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# MYCOTAXON

AN INTERNATIONAL JOURNAL FOR RESEARCH ON
TAXONOMY & NOMENCLATURE OF FUNGI, INCLUDING LICHENS

Volume LXXXIII July-September 2002

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# FUNGI OF THE EASTERN CARPATHIANS (UKRAINE) – IMPORTANT WORKS BY ALBERT PILÁT, AND LOCATIONS OF HIS COLLECTING SITES

JAN HOLEC

National Museum, Mycological Department
Václavské nám. 68, 115 79 Praha 1, Czech Republic; jan.holec@nm.cz

**ABSTRACT** Albert Pilát thoroughly studied mycoflora of the Eastern Carpathians (Ukraine) in 1928-1938. He collected especially lignicolous fungi growing in mountainous virgin forests minimally influenced by man. The results were summarized in a detailed mycofloristic contribution and the collected material also served as a basis for Pilát's well-known taxonomic monographs of Polyporaceae and the genera *Stereum*, *Pleurotus*, *Lentinus*, *Crepidotus* etc. Due to political changes after World War II, the geographic names in the Eastern Carpathians were transliterated to Russian, Ukrainian and partly also totally renamed. In present-day maps it is almost impossible to find Pilát's collecting sites. Moreover, Pilát's data are omitted in a checklist of fungi of Ukraine. To improve the knowledge of the Ukrainian mycoflora, a survey of Pilát's publications dealing with the Eastern Carpathians is given, and some new taxa described by him from this area are cited. The original names of Pilát's collecting sites are listed and their current Cyrillic-written Ukrainian equivalents and variants transliterated in Roman letters are added. Location of each locality is described and mapped. The vegetation types studied by Pilát are briefly characterized.

**KEY WORDS**: basidiomycetes, ascomycetes, lignicolous fungi, biodiversity, taxonomy

## FOREIGN STUDIES BY ALBERT PILÁT

Dr. Albert Pilát (1903-1974), outstanding Czech mycologist of world renown and long-time head of the Mycological Department, National Museum, Prague, was very active in mycofloristic studies of many European and Asian countries. In addition to thorough study of the Czech, Moravian, and Slovak mycoflora (former Czechoslovakia), he collected e.g. in Bulgaria, Macedonia, Sweden, Finland, Poland, Turkey, Mongolia, the USA, and several countries of tropical western Africa (for a survey of his foreign expeditions see Herink and Svrček 1953, Herink 1973).

## THE EASTERN CARPATHIANS – HISTORY OF THE TERRITORY IN THE 20TH CENTURY

One of Pilát's favorite collecting areas was the Eastern Carpathians, a mountainous region that belonged to the former Czechoslovakia at the time he worked in the area. Officially, the region was named „Podkarpatská Rus" (later „země Podkarpatoruská"; Carpatorossia in Latin) at that time. The area has a complicated history. During the 20th century, it belonged to the Austrian-Hungarian monarchy (up to 1918), the Czechoslovak Republic (1919-1939), Hungary (1939-1944), and in 1945 was annexed to the Soviet Union. After the break-up of the Soviet Union, the area became a part of the independent Ukraine (since 1991), where it represents a region called „Zakarpatska oblast".

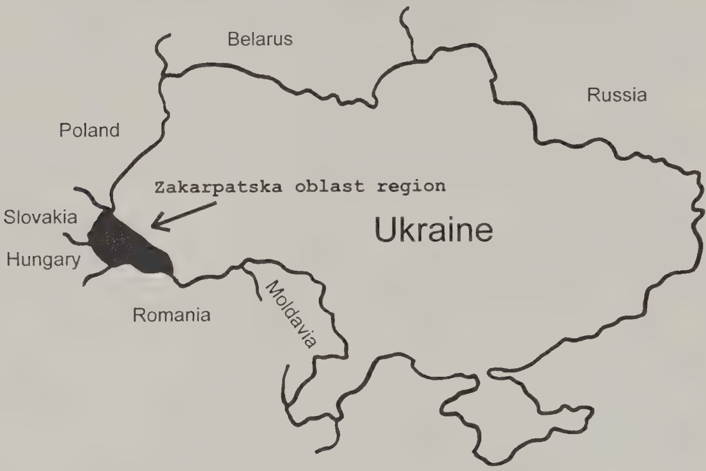

Fig. 1: Location of the Zakarpatska oblast region within Ukraine. This region was named „Podkarpatská Rus" at the time Pilát worked there and belonged to former Czechoslovakia (1919-1939). Most of its area is covered by the Eastern Carpathians.

## PILÁT'S STUDIES IN THE EASTERN CARPATHIANS

Pilát visited the Eastern Carpathians ten times in the period 1928-1938 (Pilát 1940: 37-38). He devoted himself especially to the lignicolous fungi growing in mountainous virgin forests minimally influenced by man. Such forests (mainly composed of *Fagus sylvatica, Abies alba, Acer pseudoplatanus, A. platanoides, Ulmus glabra*, *Picea abies*) are characteristic of the Eastern Carpathians. Concerning naturalness of vegetation, the Eastern Carpathians belong to the best-preserved regions in Europe.

During his intensive and lengthy fieldwork, Pilát collected several thousands of valuable and rich collections of lignicolous macromycetes. The material is kept in the herbarium of the Mycological Department, National Museum, Prague (PRM). These collections were not only cited in his final work on the mycoflora of the Eastern Carpathians (Pilát 1940), but also served as basic material for his well-known taxonomic monographs of *Polyporaceae* (Pilát 1936-1942) and the genera *Stereum* (Pilát 1930a), *Pleurotus* (Pilát 1935), *Lentinus* (Pilát 1946), *Crepidotus* (Pilát 1948) as well as for several smaller contributions (Pilát 1929, 1930, 1930-1931, 1931, 1933, 1936, 1938, 1939, 1941, 1949). Pilát also used this material for the distribution of an exsiccate collection named „Fungi Carpatici lignicoli" and for exchange with many herbaria in the world. Moreover, critical collections of Corticiaceae s.l. were sent for identification to John Eriksson (Sweden), who cited them in his publications.

Pilát described several new species of fungi from the Eastern Carpathians. These species have their type locality there. Their names are mostly derived from names of localities or the whole mountain range (*Crepidotus carpaticus, C. carpatorossicus, Trametes kuzyana* etc.). Some of them proved to be identical with earlier described taxa (see Tab. 1), but there are also generally accepted new species, e.g. *Postia simanii* (Pilát) Jülich, *Postia lowei* (Pilát) Jülich, *Tyromyces minusculoides* (Pilát) Bondartsev, *Skeletocutis stellae* (Pilát) Jean Keller, *Crepidotus carpaticus* Pilát, and *Resupinatus kavinii* (Pilát) M. M. Moser. The names of polypores published invalidly (Pilát 1936-1942, without Latin descriptions) were validated later (Pilát 1953). Some ascomycetes collected by Pilát were described as new by J. Velenovský (1934, 1940; for examples see Tab. 1) and later revised by M. Svrček (e.g. Svrček 1953, 1954, 1976, 1984) or other mycologists (e.g. Dissing 1966).

## AIM OF THIS STUDY

Due to political changes after World War II, the geographic names in the Eastern Carpathians were transliterated into Russian, then into Ukrainian and partly also totally renamed. Consequently, the names of Pilát's collecting sites changed considerably, too. In present-day maps (either Russian, Ukrainian or those transliterated into English or other languages) it is almost impossible to find his collecting sites. Moreover, detailed maps of this region are not readily available outside the Ukraine. The best available source is the maps on web site "www.infoukes.com/ua-maps/oblasts/oblast01". However, their scale (1:200,000) is too coarse and most names used by Pilát are missing there. Ukrainian and foreign mycologists mostly omit Pilát's thorough and very valuable publications on mycoflora of the Eastern Carpathians. For example, none of Pilát's works is mentioned in the checklist of Ukrainian fungi (Minter and Dudka 1996).

In the Mycological Department of the National Museum, Prague (herbarium PRM), we are aware of the increasing interest in Pilát's material collected in the Eastern Carpathians. There are many loan requests concerning type collections or valuable material from this region (especially of polypores and genera monographically elaborated by Pilát, see above). The authors mostly have problems with localization of Pilát's finds. In an effort to help them, I have decided to publish this paper.

Moreover, I visited the Eastern Carpathians in 1999. It was necesasary to know where Pilát worked 70 years ago. The journey was organized by K. Prášil (Charles University, Prague) who, together with M. Réblová (Institute of Botany, Czech Academy of Sciences, Průhonice near Prague), studied pyrenomycetes of local mountainous virgin forests during excursions in 1997 and 1998 (see e.g. Réblová 1999: 225 - description of the new species *Helminthosphaeria carpathica*).

I decided to resolve these problems in the following way:
1. Describe exactly the location of Pilát's collecting sites.
2. Give present-day Ukrainian equivalents (if existing) and their transliteration into Roman letters (only for more important geographic entities such as names of towns, villages, rivers etc. which can be found in commonly available maps).

| **Original name (etymology in parentheses)** | **Type study or revision** | **Real identity** |
|---|---|---|
| *Leptoporus carpatorossicus* Pilát ex Pilát, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 9: 102, 1953 (from „Carpatorossia“, a former Latin name for the area of the present-day Zakarpatska oblast region) | Kotlaba and Pouzar (1989: 37) | *Tyromyces kmetii* (Bres.) Bondartsev et Singer |
| *Leptoporus bourdotii* Pilát, Bull. Soc. Mycol. France 48: 167, 1932 | Kotlaba and Pouzar (1988: 130) | *Gloeoporus pannocinctus* (Rommell) J. Erikss. |
| *Leptoporus bredecelensis* Pilát, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 9: 103, 1953 (from „Bredecel“ stream, see Tab. 2) | Kotlaba and Pouzar (1988: 130) | *Spongipellis delectans* (Peck) Murrill |
| *Leptoporus zameriensis* Pilát, Bull. Soc. Mycol. France 51: 256, 1936 (from „Žámer“ gamekeeper's lodge, see Tab. 2) | Kotlaba and Pouzar (1988: 131) | *Gloeoporus pannocinctus* (Rommell) J. Erikss. |
| *Poria gilvella* Pilát, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 9: 104, 1953 | Kotlaba and Pouzar (1988: 133) | *Skeletocutis odora* (Sacc.) Ginns |
| *Poria mentschulensis* Pilát, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 9: 105, 1953 (from Mount „Menčul“, see Tab. 2) | Kotlaba and Pouzar (1988: 133) | *Antrodiella fissiliformis* (Pilát) Gilb. et Ryvarden |
| *Poria pearsonii* Pilát, Trans. Brit. Mycol. Soc. 19: 196, 1935 | Kotlaba and Pouzar (1990: 232) | *Rigidoporus corticola* (Fr.) Pouzar |
| *Poria subpudorina* Pilát, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 9: 105, 1953 | Kotlaba and Pouzar (1991: 95) | *Ceriporiopsis resinascens* (Romell) Domański |
| *Stereum carpaticum* Pilát, Hedwigia 70: 78, 1930 | | *Columnocystis ambigua* (Peck) Pouzar |
| *Trametes kuzyana* Pilát, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 9: 104, 1953 (from „Kuzy“ stream, see Tab. 2) | Kotlaba and Pouzar (1991: 96) | *Antrodia malicola* (Berk. et M.A. Curtis) Donk |
| *Crepidotus versutus* var. *subglobisporus* Pilát, Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 2: 74, 1940 | Senn-Irlet (1995: 59) | *Crepidotus lundellii* Pilát |
| *Crepidotus carpatorossicus* Pilát, Stud. Bot. Cechoslov. 10: 153, 1949 (from „Carpatorossia“, a former Latin name for area of the present-day Zakarpatska oblast region) | Senn-Irlet (1992) | *Chromocyphella muscicola* (Fr.) Donk |
| *Flammula croceolamellata* Pilát, Bull. Soc. Mycol. France 54: 251, 1939 (“1938”) | Holec (2001: 184) | *Gymnopilus* sp. |
| *Helotium albipes* Velen., Novitates Mycologicae: 183, 1940 (“1939”) | Svrček (1984: 132-133) | probably a *Bisporella* sp. |
| *Helvella rossica* Velen., Novitates Mycologicae: 204, 1940 (“1939”) | Dissing (1966: 131, 134), Svrček (1976: 137) | *Helvella elastica* Bull.: Fr. |
| *Orbilia carpathica* Velen., Monographia discomycetum bohemiae: 103, 1934 | Svrček (1954: 12) | *Orbilia luteo-rubella* f. *pellucida* (Velen.) Svrček |
| *Orbilia connata* Velen., Monographia discomycetum bohemiae: 95, 1934 | Svrček (1954: 12) | *Orbilia epipora* P. Karst. |

| **Original name** | **Type study or revision** | **Real identity** |
|---|---|---|
| *Orbilia microspora* Velen., Monographia discomycetum bohemiae: 95, 1934 | Svrček (1954: 17) | *Orbilia delicatula* (P. Karst.) P. Karst. |
| *Parthenope pilati* Velen., Novitates Mycologicae: 189, 1940 ("1939") | | ? |
| *Pseudotapesia pilati* Velen., Novitates Mycologicae: 180, 1940 ("1939") | Svrček (1953: 214, as *Catinella nigroolivacea*) | *Catinella olivacea* (Batsch: Fr.) Boud. |
| *Septatium carpaticum* Velen., Novitates Mycologicae: 188, 1940 ("1939") | | ? |

Tab. 1: Examples of some fungal taxa described by A. Pilát or J. Velenovský from the Eastern Carpathians. Generally accepted new species are not included (these are mentioned in paragraph „Pilát's studies in the Eastern Carpathians").

## METHODS

The location of Pilát's collecting sites was identified using maps issued by the Military Geographic Institute in Prague in the 1930s (scale 1:75,000), which were used by Pilát himself, as well. I studied a set kept in the Map Collection of Charles University Prague, Faculty of Sciences. The maps are very detailed and names of almost all geographic entities (mountains, small streams etc.) are provided. As commonly available Ukrainian maps are not so detailed and many of Pilát's collecting sites cannot be found there, the maps 1:75,000 cited above were used as a matrix for the preparation of figures (Figs. 3-8).

The source of present-day Ukrainian names was the official physical map of the Zakarpatska oblast region printed in Kiev (Ukraine) in 1999 (scale 1:200,000). Unfortunately, some names of Pilát's collecting sites are not included there.

For transliteration of Ukrainian names into Roman letters, the standard used by Minter and Dudka (1996: 9) was accepted with one exception: for ASCII values 137: „Й" (in Cyrillic) and 169: „й" (in Cyrillic) the combination „YI" and „yi" was used instead of „I<breve>" and "i<breve>". Transliteration of some names used in the Euro-map of Belarus, Russia, and Ukraine issued by Marco Polo (ISBN 3-89525-002-2) is added to Tab. 2. These maps are readily available and some towns, villages, rivers or areas mentioned by Pilát can be found there (both in Cyrillic and Roman letters, for Pilát's equivalents see Tab. 2).

In the whole paper, Czechoslovak names of localities used by Pilát are given in quotation marks. The elevations given in geographic schemes (Figs. 3-8) are taken mostly from Czechoslovak maps at a scale of 1:75,000 (see above). They can differ from the recent measurements, which were unavailable for me except for elevation of several mountains given in the Ukrainian map 1:200,000 (see above).

Abbreviation: Ukr. - Ukrainian

| **Name by Pilát (1940)** | **Other Czechoslovak variants** | **Characterization** | **Present-day Ukrainian name** | **Transliteration according to Minter and Dudka (1996)** | **Transliteration in Marco Polo maps** |
|---|---|---|---|---|---|
| Užhorod | | town | Ужгород | Uzhhorod | Užhorod |
| Mukačevo | | town | Мукачеве | Mukacheve | Mukačeve |
| Ždeňová | Žděňovo | village | Жденієве | Zhdeniyeve | Ždeneve |
| Svaljava | | small town | Свалява | Svalyava | Svaljava |
| Volové | | small town | Міжгір'я | Mizhhir'ya | Mižhir'ja |
| Berehovo | | small town | Берегове | Berehove | Berehove |
| Chust | | town | Хуст | Khust | Chust |
| Terešva | Teresva | village | Тересва | Teresva | Teresva |
| Trebušany | | village | Ділове | Dilove | Dilove |
| Rachov | | small town | Рахів | Rakhiv | Rachiv |
| Kakašovce | | ? | ? | | |
| **Gorgány** | | **range of mountains** | **Горгани** | **Horhani** | **Horhany** |
| Bradula | | hunting cottage | Бpaдiл | Bradil | |
| Mokranka | | stream valley | Мокрянка | Mokryanka | |
| Dlhý Gruň | Douhy gruň | mountain ridge | ? | | |
| Německá Mokrá | | village | Комсомольськ | Komsomol's'k | Komsomol's'k |
| Velký Gorgán | | mountain | Горган (Кінець Горгану) | Horhan (Kinets' Horhanu] | |
| **Svidovec** | | **range of mountains** | **хребет Свидовець** | **khrebet Svidovets'** | **Svidovec'** |
| Krajná Rika | Krajná Rjeka, Krajná rika | river valley | Мала Шопурка | Mala Shopurka | |
| Žámer | Kazmer | gamekeeper's lodge | ? | | |
| Popitník | | gamekeeper's lodge | ? | | |
| Dragobrat | Drahobrat | tourist chalet | Драгобрат | Drahobrat | |
| Kosovská Rika | Kosovská rika | river valley | Косівська | Kosiv's'ka | Kosivs'ka |
| Velký Bočkov | | village | Вел. Бичків | Vel. Bichkiv | Vel. Byčkiv |
| Luh | | small village | Луг | Luh | Luh |
| Velký Baňský | | stream valley | ? | | |
| Kuzy | | stream valley above Kuzy hunting-lodge | ? | | |
| Bredecel | | stream valley NW of Trebušany | ? | | |

| **Name by Pilát (1940)** | **Other Czechoslovak variants** | **Characterization** | **Present-day Ukrainian name** | **Transliteration according to Minter and Dudka (1996)** | **Transliteration in Marco Polo maps** |
|---|---|---|---|---|---|
| Tiščora | | hunting cottage near Trebušany | ? | | |
| Kalpiš | | ??? | ? | | |
| Menčul | | mountain | Менчул | Menchul | |
| Kedrym | | ??? | ? | | |
| Jalinka | | a locality near Kosovská Polana | ? | | |
| Kosovská Polana | | village | Косівська Поляна | Kosiv's'ka Polyana | Kosivs'ka Poljana |
| Kobylecká Polana | | village | Кобилецька Поляна | Kobilets'ka Polyana | Kobylec'ka Poljana |
| Gaňa | | valley above Kobylecká Polana | ? | | |
| **Čorná Hora** | | **range of mountains** | **хребет Чарногора** | **khrebet Charnohora** | **Čornohora** |
| Bohdan | Bogdan | village | Богдан | Bohdan | Bohdan |
| Hoverla | | mountain | Говерла | Hoverla | Hoverla |
| klausura Hoverla | | small water reservoir | ? | | |
| Brescul | Breskul,<br>Breckul | mountain + mountain plateau | ? | | |
| Turkul | | mountain | Туркул | Turkul | Turkul |
| Brebenjescul | Brebeněskul | stream valley | ? | | |
| Kvasovský Menčul | | mountain | Менчул | Menchul | |
| **Pop Ivan** | | **range of mountains** | **Pip-Іван** | **Pip-Ivan** | **Pip-Ivan** |
| Berlebáš | Berlebaš | stream valley | Великий | Velikiyi | Velykyj |
| in monte Berlebaška | | mountain | ? | | |
| Liščenka | | stream valley | ? | | |
| Bílý Potok | | stream valley | Білий | Biliyi | Bilyj |
| Strunžín prope Trebušany | Strunzeň gruň | E of Trebušany (slopes above Bílý potok stream) | ? | | |

Tab. 2: Collecting sites studied by A. Pilát in the Eastern Carpathians (arranged according to his 4 collecting areas which are typed in bold face). Source of names: mainly Pilát (1940), occasionally other publications by Pilát cited in Introduction. Present-day Ukrainian equivalents and their transliteration into Roman letters are provided (if available). For details on terminology see chapters Methods and Results.

## TERMINOLOGY OF PILÁT'S COLLECTING SITES IN THE CZECHOSLOVAK PERIOD (1919-1939)

The names of collecting sites used by Pilát in his works are written in their Czechoslovak version (with typical punctuation marks, see Tab. 2). One of the most detailed sources of geographic names were maps (scale 1:75,000) issued by the Military Geographic Institute in Prague („Vojenský zeměpisný ústav v Praze"). A rare collection of these maps is kept in the Botanical Department of the National Museum where Pilát worked before World War II. It is to be expected that Pilát used geographic names from these maps. Moreover, he certainly used some place names used by local people, e.g. foresters. These names cannot be found in any maps available at present. Unfortunately, the terminology and spelling of geographic names used in the period 1919-1939 was not stable. Usually there are two or even more variants of the same name differing in spelling, punctuation marks, usage of capitals etc. (e.g. „Žámer" vs. „Kazmer", „Bogdan" vs. „Bohdan", „Gorgany" vs. „Gorgány", „Krajná rika" vs. „Krajná Rika" vs. „Krajnia rika"). Consequently, the variants Pilát wrote on labels of his collections kept in PRM sometimes slightly differ from the same name cited in his publications. In this paper, I mainly discuss the names Pilát used in his final work on the mycoflora of the Eastern Carpathians (Pilát 1940).

## GEOGRAPHIC NAMES DURING THE SOVIET AND UKRAINIAN PERIOD[1]

With the inclusion of this area into former Soviet Union (1945-1991), the geographic names were mostly transliterated into Russian (Cyrillic alphabet) or, to a lesser degree, totally renamed („Trebušany" → Dilove, „Německá Mokrá" → Komsomol's'k). The transfer to Russian was sometimes connected with slight change of pronunciation or spelling (e.g. „Uzhhorod" → Uzhgorod). Recently, as the area now belongs to the Ukraine, the Russian versions of names have been transliterated into Ukrainian. This brought e.g. change of „o" to „i" („Rakhov" → Rakhiv) or return to the original pronunciation (Uzhgorod → Uzhhorod). For people who do not know the historical circumstances and languages such as Czech, Russian and Ukrainian, the names of most collecting sites used by Pilát cannot be found in present-day Ukrainian or Russian maps. It is even hard to find them in original Czechoslovak maps, as they are mostly names of small streams, valleys, single buildings (e.g. tourist chalets) etc.

## LOCATION OF PILÁT'S COLLECTING SITES[2]

A detailed survey of Pilát's excursions (year and site) is given by Herink and Svrček (1953: 146-147) and partly also by Pilát himself (1940: 37-38). Except for several collections made in towns and villages or in their vicinity (see first part of Tab. 2), Pilát's localities are concentrated in 4 main collecting areas (Fig. 2).

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[1] * All Russian and Ukrainian names originally written in Cyrillic are transferred to Roman letters, for the standard of transliteration see Material and Methods

[2] ** All Ukrainian names originally written in Cyrillic are transferred into Roman letters; names of geographic entities are given in Ukrainian followed by the Czech name used by Pilát (1940) in parentheses and quotation marks

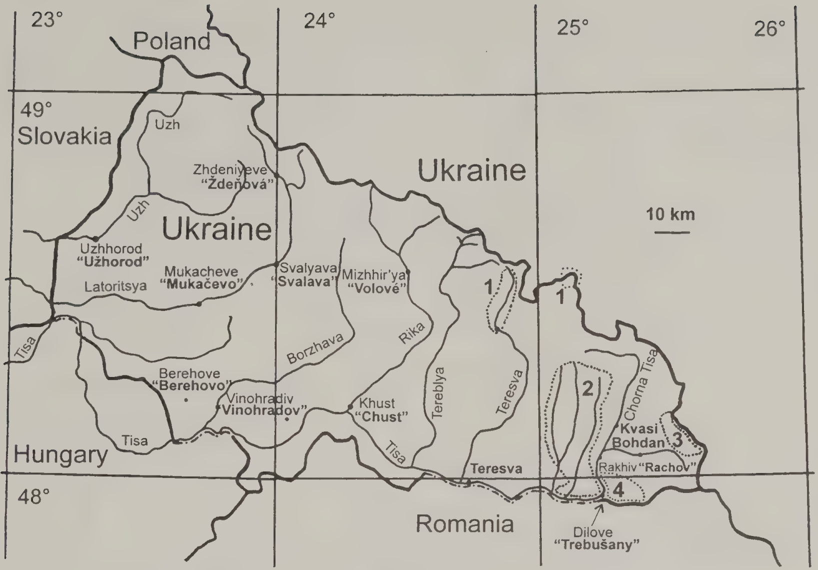
23°
24°
25°
26°
Poland
49°
Slovakia
Uzh
Zhdeniyeve
"Ždeňová"
Ukraine
Ukraine
10 km
Uzh
Uzhhorod
"Užhorod"
Mukacheve
"Mukačevo"
Latoritsya
Svalyava
"Svalava"
Mizhhir'ya
"Volové"
1
1
Borzhava
Rika
Tisa
Berehove
"Berehovo"
Vinohradiv
"Vinohradov"
Khust
"Chust"
Tereblya
Teresva
2
Chorna Tisa
Kvasi
Bohdan
3
Hungary
Tisa
Tisa
Teresva
Rakhiv "Rachov"
4
48°
Romania
Dilove
"Trebušany"

Fig. 2: Pilát's main collecting areas within the Zakarpatska oblast region. Names of collecting sites studied by Pilát are printed in bold face. Czech names used in his publication (Pilát 1940) are given in parentheses. 1: Horhani („Gorgány", Figs. 3, 4), 2: Svidovets' („Svidovec", Figs. 5, 6), 3: Charnohora („Čorná hora", Fig. 8), 4: Pip-Ivan („Pop Ivan", Fig. 7).

## „Gorgány" (Horhani in Ukr.)

Horhani is a range of mountains in the northeastern part of the Zakarpatska oblast region (Fig. 2). The range forms a natural border between this region and the Ivano-Frankivska oblast region (capital city Ivano-Frankivsk). In the period 1919-1939 there was a border between Czechoslovakia and Poland. Pilát collected in Horhani in August 1932 (Pilát 1940: 37), especially in the Mokryanka („Mokranka") stream valley in the vicinity of the Bradil („Bradula") hunting cottage and the village of Komsomol's'k („Německá Mokrá", Fig. 4). In his paper (Pilát 1940), some collections from Mount „Velký Gorgán" (Fig. 3) and the „Dlhý gruň" ridge (Fig. 4) are also cited. The name „Gorgán" (Horhan in Ukrainian) is used for several peaks in the Horhani mountain range (see Fig. 3). I suppose that Pilát had in mind southern slopes of the mountain group with peaks reaching 1580 and 1611 m above sea level.

## „Svidovec" (khrebet Svidovets' in Ukr.)

This is a mountain group between the rivers Teresva and Tisa (Fig. 2, 5, 6) with the highest peak Bliznitsya („Bliznica", 1880 m above sea level). Mountain ridges in this area are separated by long and narrow river valleys running north-south. Pilát collected here in August 1929, 1930, 1933, 1934, and 1938 (Pilát 1940: 37-38). He explored valleys of several streams („Velký Baňský", „Kuzy", „Bredecel"; Fig. 6) and slopes of

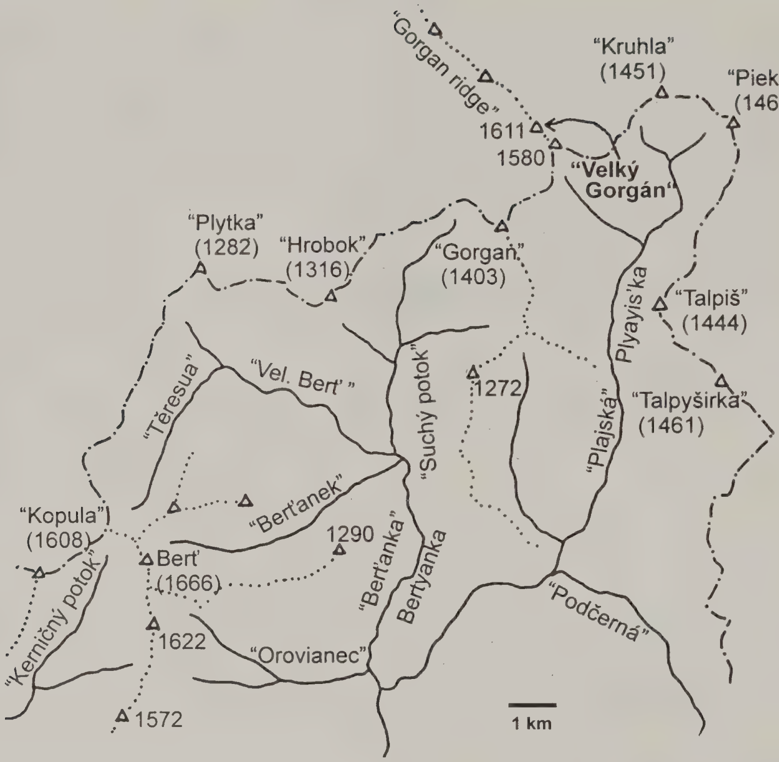
"Gorgan ridge"
"Kruhla"
(1451)
"Pieklo"
(1465)
1611
1580
"Velký
Gorgán"
"Plytka"
(1282)
"Hrobok"
(1316)
"Gorgan"
(1403)
Plyayis'ka
"Talpiš"
(1444)
"Těresua"
"Vel. Berť"
"Suchý potok"
1272
"Talpyširka"
(1461)
"Plajská"
"Kopula"
(1608)
"Berťanek"
1290
Berť
(1666)
"Berťanka"
Bertyanka
"Podčerná"
"Kerničný potok"
1622
"Orovianec"
1572
1 km

Fig. 3: Collecting sites studied by A. Pilát in Horhani („Gorgány") area (Fig. 2, no. 1 right). Vicinity of the „Gorgan" mountain group. The geographic content (including names and elevations) is taken from maps issued by the Military Geographic Institute Prague, sheets „Brustury" (4672), 1932; and „Porohy" (4572), 1935. Names of collecting sites studied by Pilát are printed in bold face. Explanations: full lines: rivers and streams, dotted lines: mountain ridges, triangles: mountaintops, dot-and-dash line: border of the Zakarpatska oblast region.

the Mount Menchul („Menčul", Fig. 6) between the villages of Vel. Bichkiv („Velký Bočkov", Fig. 6) and Dilove („Trebušany", Fig. 6). The „Tiščora" hunting cottage near Dilove was also in this area (I do not know if it exists at present). Furthermore, Pilát worked in valleys of the rivers Mala Shopurka („Krajná Rika"), Serednya („Serednia rika"), and Kosiv's'ka („Kosovská Rika", Fig. 5 in all cases). In these valleys he visited the surrounding of the villages Kobylets'ka Poljana („Kobylecká Polana"), Kosiv's'ka Polyana („Kosovská Polana") and the vicinity of the gamekeeper's lodges „Žámer" and „Popitník" (Fig. 5). Occasionally he collected in the Bliznitsya area near the Dragobrat tourist chalet (Fig. 5). I was not able to localize sites called „Kedrym" and „Kalpiš" more exactly.

### „Čorná hora“ (khrebet Charnohora in Ukr.)

Charnohora is a range of mountains in the easternmost part of the Zakarpatska oblast region (Figs. 2, 8). The range forms a natural border between this region and the Ivano-Frankivska oblast region (capital city Ivano-Frankivsk). In the period 1919-1939 there was a border between Czechoslovakia and Poland here. Pilát collected here in August 1928 (Pilát 1940: 37-38). This mountain group is the highest one of the Eastern Carpathians. The highest peak is Hoverla (2060 m above sea level). Pilát studied the mycoflora on slopes of mountains in the Charnohora mountain range (Fig. 8): Hoverla, „Brescul“, and Turkul. Furthermore, he explored valleys of streams Hoverla (vicinity of the former small water reservoir „klausura Hoverla“) and „Brebenjescul“ (Fig. 8). Scattered collections are from Mount „Kvasovský Menčul“ (Fig. 8) near the village of Kvasi. In the Charnohora area, spruce (*Picea abies*) is more frequent than in other parts of the Eastern Carpathians where *Fagus* dominates almost up to the timberline. Therefore, many collections from this area are from decaying trunks of spruce.

### „Pop Ivan“ (Pip-Ivan in Ukr.)

Mountainous area east of Rakhiv („Rachov“), Dilove („Trebušany“), and north of the border with Romania (see Figs. 2, 7). The highest peak is Pip-Ivan („Pop Ivan“, 1937 m above sea level). Pilát worked here in August and October 1935 and in August 1936 and 1937 (Pilát 1940: 37-38). He collected mainly in valleys of streams Velikiyi („Berlebáš“), „Liščenka“, and Biliyi („Bílý potok“) flowing into the Tisa river east or northeast of Dilove („Trebušany“). He also visited slopes of the Mount „Berlebaška“ and the „Strunžín“ ridge above the Biliyi („Bílý potok“) stream (Fig. 7).

### Vegetation types studied by Pilát

The Zakarpatska oblast region is rich in forests minimally influenced by man. Stands having a virgin forest character are still preserved. These forests are especially suitable for lignicolous fungi due to a great number of declining, dead or fallen trunks in various stage of decay. At the time Pilát worked there, their area was much larger than at present. The main vegetation types mycologically explored by Pilát are the following ones:

Oak-hornbeams forests are present in the lowlands and uplands along the Tisa river. They were little studied by Pilát but several records cited from towns are probably from remnants of such forests.

Beech forests dominated by *Fagus sylvatica* but with admixted *Acer platanoides*, *Acer pseudoplatanus, Ulmus glabra,* and *Abies alba*. Beech forests represent the main forest community of the Eastern Carpathians, growing optimally at elevations of 500-900 m. In the Zakarpatska oblast region they cover about two thirds of the area covered by forests (from uplands, in a few instances from lowlands, up to the mountainous belt; at places forming the timberline). Locally there are fir forests dominated by *Abies alba* with admixted *Fagus sylvatica, Acer pseudoplatanus,* and *Picea abies* or mixed mountainous forests composed of *Fagus, Abies*, and *Picea*. These forest communities were preferentially studied by A. Pilát, especially in the Svidovets' („Svidovec“) and Horhani („Gorgány“) area.

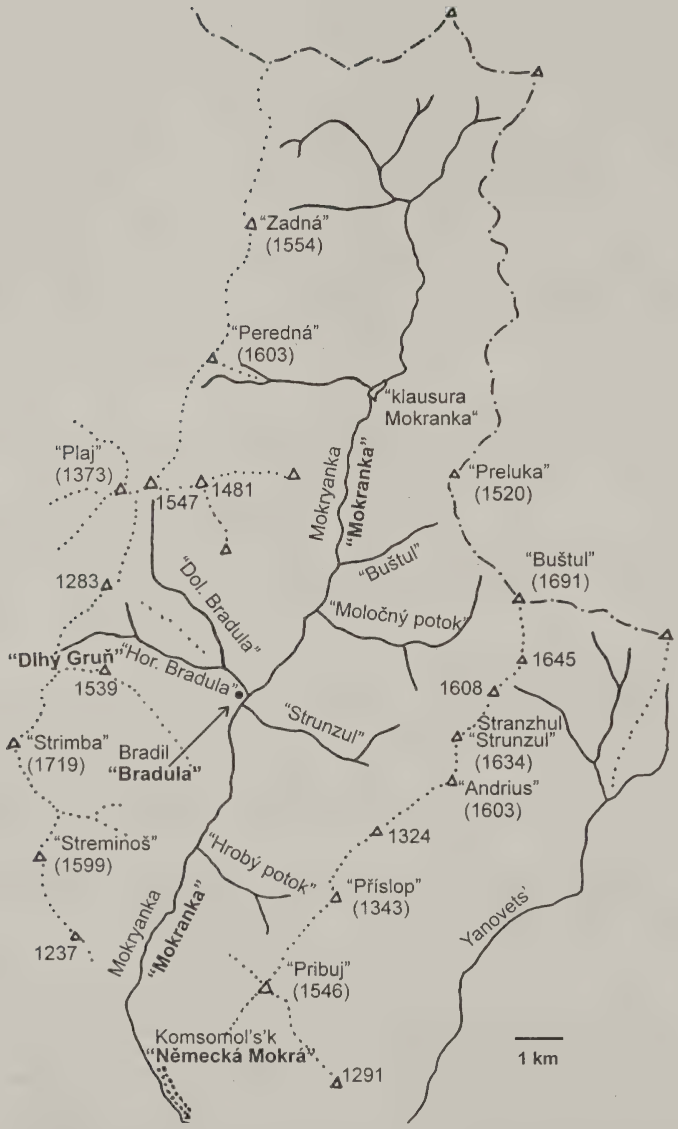
"Zadná"
(1554)
"Peredná"
(1603)
"klausura
Mokranka"
"Plaj"
(1373)
1547
1481
Mokryanka
"Mokranka"
"Preluka"
(1520)
"Buštul"
"Buštul"
(1691)
1283
"Dol. Bradula"
"Moločný potok"
"Dlhý Gruň"
"Hor. Bradula"
1539
1645
1608
"Strunzul"
Stranzhul
"Strunzul"
(1634)
"Strimba"
(1719)
Bradil
"Bradula"
"Andrius"
(1603)
"Streminoš"
(1599)
1324
"Hroby potok"
"Příslop"
(1343)
1237
Mokryanka
"Mokranka"
Yanovets'
"Pribuj"
(1546)
Komsomol's'k
"Německá Mokrá"
1291
1 km

Fig. 4: Collecting sites studied by A. Pilát in the Horhani („Gorgány") area (Fig. 2, no. 1 left). Area surrounding the Mokryanka („Mokranka") stream. The geographic content (including names and elevations) is taken from maps issued by the Military Geographic Institute Prague, sheets „Horinčovo" (4671), 1932; and „Porohy" (4572), 1935. Names of collecting sites studied by Pilát are printed in bold face. Explanations: full lines: rivers and streams, dotted lines: mountain ridges, triangles: mountaintops, dot-and-dash line: border of the Zakarpatska oblast region.

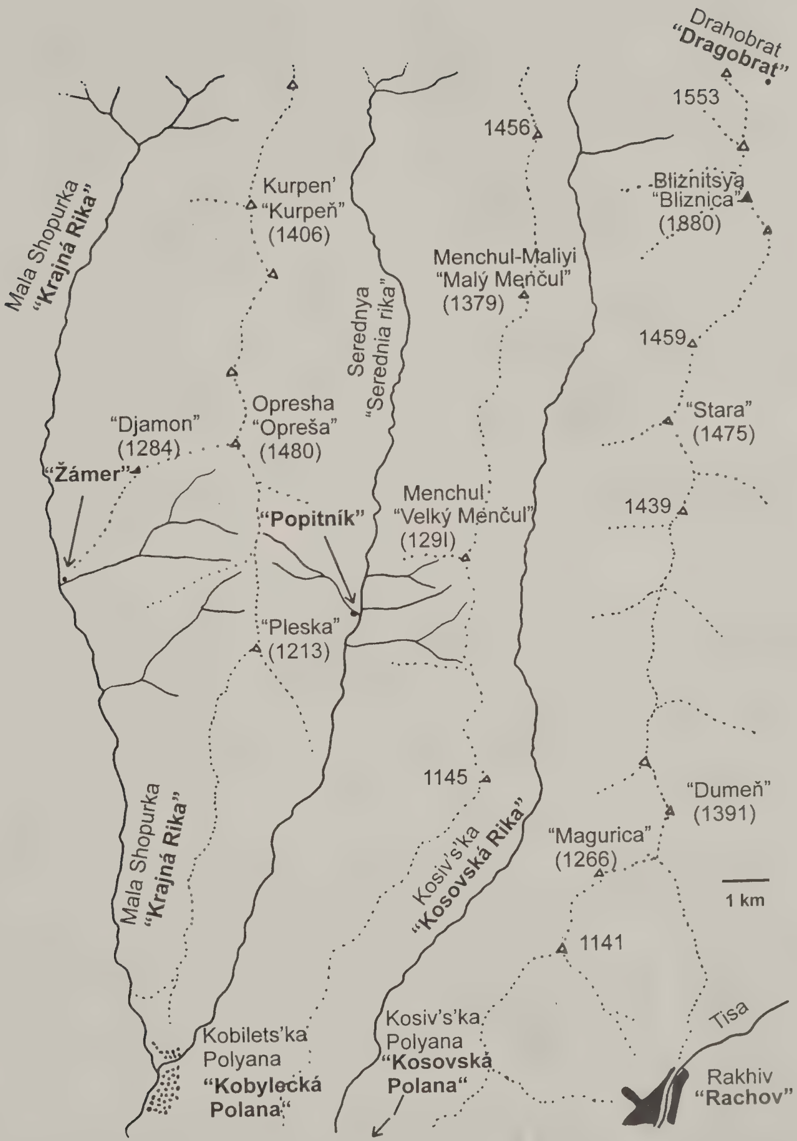
Drahobrat
"Dragobrat"
1553
1456
Mala Shopurka
"Krajná Rika"
Kurpen'
"Kurpeň"
(1406)
Bliznitsya
"Bliznica"
(1880)
Menchul-Maliyi
"Malý Menčul"
(1379)
Serednya
"Serednia rika"
1459
Opresha
"Opreša"
(1480)
"Djamon"
(1284)
"Žámer"
"Stara"
(1475)
Menchul
"Velký Menčul"
(1291)
"Popitník"
1439
"Pleska"
(1213)
1145
Mala Shopurka
"Krajná Rika"
Kosiv's'ka
"Kosovská Rika"
"Dumeň"
(1391)
"Magurica"
(1266)
1 km
1141
Tisa
Kosiv's'ka
Polyana
"Kosovská
Polana"
Kobilets'ka
Polyana
"Kobylecká
Polana"
Rakhiv
"Rachov"

Fig. 5: Collecting sites studied by A. Pilát in Svidovets' („Svidovec") area, northern part (Fig. 2, no. 2). The geographic content (including names and elevations) is taken from maps issued by the Military Geographic Institute Prague, sheet „Rachov" (4772), 9th edition, about 1935. Names of collecting sites studied by Pilát are printed in bold face. Explanations: full lines: rivers and streams, dotted lines: mountain ridges, triangles: mountaintops.

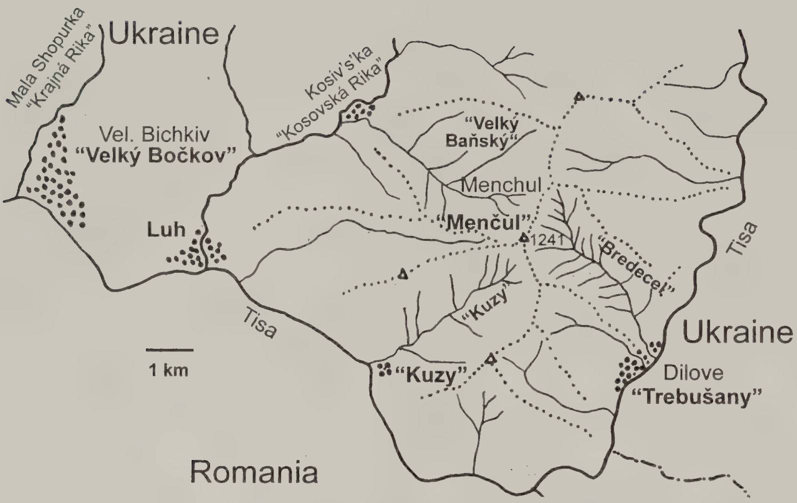
Mala Shopurka
"Krajná Rika"
Ukraine
Vel. Bichkiv
"Velký Bočkov"
Kosiv's'ka
"Kosovská Rika"
"Velký
Baňský"
Menchul
"Menčul"
1241
"Bredecel"
Luh
Tisa
1 km
"Kuzy"
"Kuzy"
Tisa
Ukraine
Dilove
"Trebušany"
Romania

Fig. 6: Collecting sites studied by A. Pilát in the Svidovets' („Svidovec") area, southern part (Fig. 2, no. 2). For explanations see below.

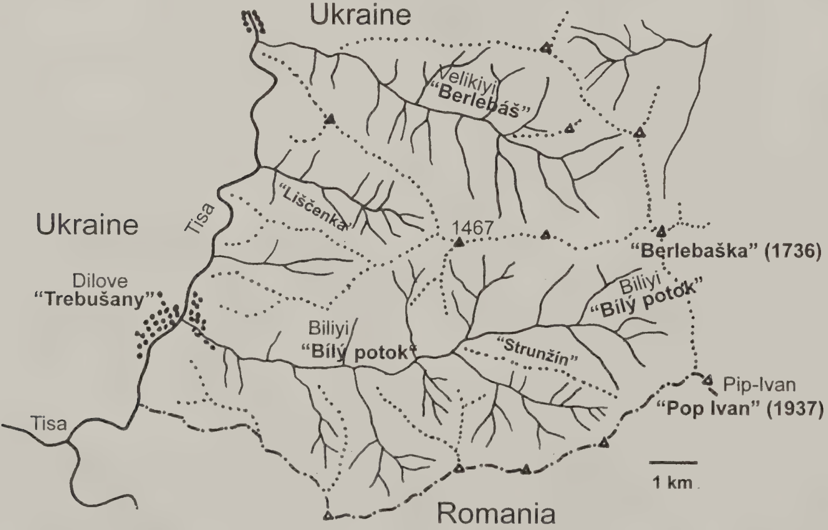
Ukraine
Velikiyi
"Berlebáš"
"Liščenka"
Ukraine
Tisa
1467
"Berlebaška" (1736)
Dilove
"Trebušany"
Biliyi
"Bílý potok"
Biliyi
"Bílý potok"
"Strunžín"
Pip-Ivan
"Pop Ivan" (1937)
Tisa
1 km
Romania

Fig. 7: Collecting sites studied by A. Pilát in the Pip-Ivan („Pop Ivan") area (Fig. 2, no. 4). The geographic content (including names and elevations) is taken from maps issued by the Military Geographic Institute Prague, sheet „Veliký Bočkov" (4872), 1934. Names of collecting sites studied by Pilát are printed in bold face. Explanations: full lines: rivers and streams, dotted lines: mountain ridges, triangles: mountaintops, dot-and-dash line: border between Ukraine and Romania.

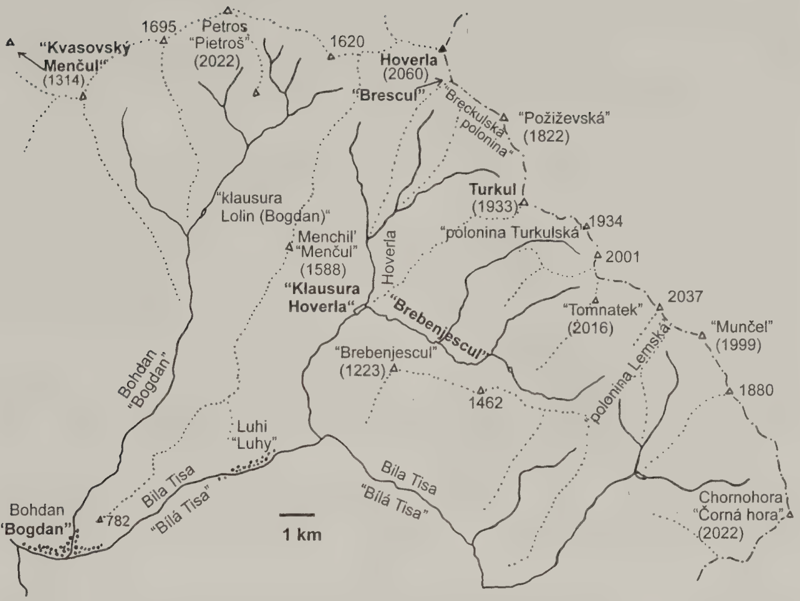
"Kvasovský Menčul"
(1314)
1695
Petros
"Pietroš"
(2022)
1620
Hoverla
(2060)
"Brescul"
Breckulská polonina"
"Poživževská"
(1822)
Turkul
(1933)
1934
"polonina Turkulská"
2001
"klausura Lolin (Bogdan)"
Menchil'
"Menčul"
(1588)
"Klausura Hoverla"
Hoverla
"Brebenjescul"
"Tomnatek"
(2016)
2037
"Munčel"
(1999)
"Brebenjescul"
(1223)
1462
polonina Lemska
1880
Bohdan
"Bogdan"
Luhi
"Luhy"
Bila Tisa
"Bílá Tisa"
Bila Tisa
"Bílá Tisa"
Bohdan
"Bogdan"
782
1 km
Chornohora
"Čorná hora"
(2022)

Fig. 8: Collecting sites studied by A. Pilát in the Charnohora („Čorná hora") area (Fig. 2, no. 3). The geographic content (including names and elevations) is taken from maps issued by the Military Geographic Institute Prague, sheet „Bohdan" (4773), 5th edition, about 1934. Names of collecting sites studied by Pilát are printed in bold face. Explanations: full lines: rivers and streams, dotted lines: mountain ridges, triangles: peaks of mountains, dot-and-dash line: border of the Zakarpatska oblast region.

Mixed ravine and slope forests on screes and ravines that are composed of *Acer platanoides, A. pseudoplatanus, Fraxinus excelsior,* and *Ulmus glabra.*

Spruce forests (*Picea abies*), either pure or with *Sorbus aucuparia, Juniperus sabina, Duschekia alnobetula* (= *Alnus viridis*) or *Pinus cembra* (higher elevations near the timberline) or with admixted *Abies alba, Fagus sylvatica, Acer pseudoplatanus* and *Ulmus glabra* (in the easternmost part from 700 m above sea level). Such forests were studied by Pilát especially in the areas of Charnohora („Čorná hora"), Pip-Ivan („Pop Ivan") and higher parts of the Horhani („Gorgány") mountain range.

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# PHYLOGENY OF AGARICS: PARTIAL SYSTEMATICS SOLUTIONS FOR CORE OMPHALINOID GENERA IN THE AGARICALES (EUAGARICS)

Scott A. Redhead
*Systematic Mycology and Botany*
*Eastern Cereal and Oilseed Research Centre*
*Research Branch, Agriculture and Agri-food*
*Ottawa, Ontario, Canada, K1A 0C6*

and

François Lutzoni, Jean-Marc Moncalvo, and Rytas Vilgalys
*Department of Biology, Duke University*
*Durham, NC 27708-0338, USA*

*Abstract:* The taxonomy of species previously assigned to *Omphalina* sensu lato or *Clitocybe* is reevaluated in light of recent molecularly-based phylogenetic hypotheses. Nomenclatural complications involving generic and specific names, lectotypifications and changes to the Code are analysed. *Lichenomphalia* gen. nov. (type *Hygrophorus hudsonianus*, syn. *Omphalina hudsoniana*) is proposed for lichenized former omphalinas. *Ampulloclitocybe* gen. nov. (type *Agaricus clavipes*, syn. *Clitocybe clavipes*) is erected for its type species. *Arrhenia* is emended to include greyish species formerly included in *Omphalina*, but excluding reddish brown species related to *Omphalina pyxidata*, the conserved lectotype for *Omphalina*. The genera *Cantharellula*, *Chrysomphalina*, *Gerronema*, *Glabrocyphella*, *Gliophorus*, *Haasiella*, *Hygrophorus*, *Hygrocybe*, *Pseudoarmillariella*, and *Rickenella*, and the generic names *Botrydina*, *Coriscium*, *Leptoglossum*, *Phaeotellus*, *Phytoconis*, and *Semiomphalina* are discussed.

Key words: basidiolichen, *Ampulloclitocybe*, *Arrhenia*, *Lichenomphalia*, *Omphalina*, *Gerronema*.

## Introduction

As noted in the accompanying article on omphalinoid mushrooms that may have evolved outside of the Agaricales (Redhead et al, 2002), the omphalinoid and clitocyboid habits represent simple agaric morphologies that presumably arose multiple times. This hypothesis is well-supported by analyses that distantly separate several omphalinoid clades, including a lineage encompassing *Rickenella* Raithelh., possibly outside of the Agaricales (Moncalvo et al. 2000 & 2002; Redhead et al. 2002). In the present paper, we discuss the systematics and biology of several genera with omphalinoid basidiomata, including clades containing the conserved lectotype for the name *Omphalina* Quél., viz. *O. pyxidata* (Pers.: Fr.) Quél. (see Greuter et al. 2000, p. 192; see Kuyper 1995 for authorship), and type species for the names *Arrhenia* Fr., *Leptoglossum* P. Karst., and *Phaeotellus* Kühner & Lamoure, as well as the lichenized omphalinoid taxa previously referred to a lichenized genus for which the rejected names *Phytoconis* Bory, *Botrydina* Bréb., and *Coriscium* Vain. (see Greuter et al. 2000, pgs. 393-395), were applied. The discussion necessarily involves the generic name *Gerronema* Singer (1951a), because Singer (1970, 1986), and those who followed his classification, included the lichenized omphalinoid taxa within the enlarged concept he ultimately adopted for that genus.

Stereotypical omphalinoid species fall into at least five inferred lineages within the greater Agaricales (= euagaric clade) using ITS and LSU data (Lutzoni 1997) and as supported by LSU data alone but using a much larger taxon sampling (Moncalvo et al. 2000 & 2002). These lineages are: **(1)** *Gerronema* sensu stricto (Singer 1951a, emended by Redhead 1986) non Singer (1986), e.g., *G. strombodes* (Berk. & Mont.) Singer and *G. subclavatum* (Peck) Singer ex Redhead; **(2)** *Chrysomphalina* Clémençon sensu stricto (emended by Redhead 1986, Norvell et al. 1994) non Clémençon (1982), e.g., *C. chrysophylla* (Fr.) Clémençon and *C. grossula* (Pers.) Norvell et al. (syn. *Omphalina wynniae* (Berk. & Br.) Ito); **(3)** the primarily bryophilous grey and brownish grey pigmented *Arrhenia-Phaeotellus-Omphalina epichysium* clade; **(4)** the lichenized omphalinas (*Botrydina* & *Phytoconis* of Redhead & Kuyper 1987, 1988, Norvell et al. 1994, Kuyper 1995); and **(5)** the *Omphalina pyxidata* group = *Clitocybe* sect. *Pyxidatae* sensu Bigelow (1974, 1985) and Lamoure (1974) *pro parte*. A distinct omphalinoid lineage, **(6)** e.g., *Rickenella* and allies (*Cantharellopsis* Kuyper, *Cotylidia* P. Karst., *Loreleia* Redhead et al., *Contumyces* Redhead et al., *Sphagnomphalia* Redhead et al.), which possibly evolved independently outside of the Agaricales (Moncalvo et al. 2000 & 2002), is treated in a separate paper (Redhead et al. 2002).

All 6 lineages were previously supported by the equally weighted parsimony and maximum likelihood analyses of the combined ITS and LSU data set (Lutzoni 1997, figs. 5a, 7). In larger taxon samplings (Moncalvo et al. 2000 & 2002), these clades of omphalinoid agarics often appear separated from each other and interspersed with clades of agarics and other fungi not previously analysed by Lutzoni (1997), some being additional omphalinoid agarics. We reproduce Lutzoni's (1997, fig. 7) as our **Fig. 1**, but with the various clades reclassified and renamed as discussed below.

## Taxonomy and nomenclature

*Gerronema* was originally proposed for lignicolous tropical species (Singer 1951a) that were latter characterized, in part, by the presence of sarcodimitic tissues (Redhead 1986, Norvell et al. 1994). Two such species, *G. strombodes* and *G. subclavatum*, formed a monophyletic unit in the analyses by Lutzoni (1997). Subsequently they were shown to be distantly related to other omphalinas (Moncalvo et al. 2000). In a much larger analysis (Moncalvo et al. 2002), these two species of *Gerronema* cluster with other taxa with sarcodimitic tissues (e.g., with species assigned to *Clitocybula* (Singer) Métrod, *Hydropus* (Kühner) Singer, *Megacollybia* Kotl. & Pouz., cf. Redhead, 1987), which together form a well-supported lineage (to be treated in a separate paper). Hence, neither the lichenized omphalinas nor *Rickenella* and allies are closely related to *Gerronema* sensu stricto.

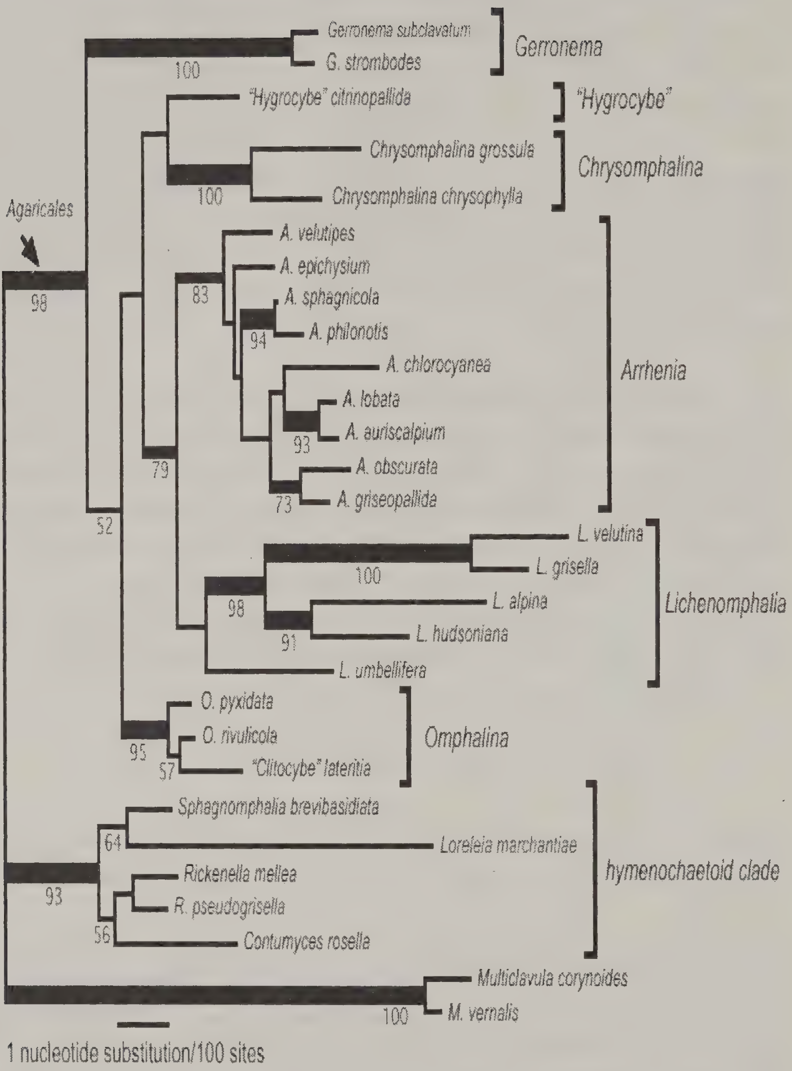
Gerronema subclavatum
G. strombodes
100
Gerronema
"Hygrocybe" citrinopallida
"Hygrocybe"
Chrysomphalina grossula
Chrysomphalina chrysophylla
100
Chrysomphalina
Agaricales
98
A. velutipes
A. epichysium
83
A. sphagnicola
A. philonotis
94
A. chlorocyanea
A. lobata
A. auriscalpium
93
A. obscurata
A. griseopallida
73
79
52
Arrhenia
L. velutina
L. grisella
100
L. alpina
98
L. hudsoniana
91
L. umbellifera
Lichenomphalia
O. pyxidata
O. rivulicola
"Clitocybe" lateritia
95
57
Omphalina
Sphagnomphalia brevibasidiata
64
Loreleia marchantiae
Rickenella mellea
R. pseudogrisella
Contumyces rosella
93
56
hymenochaetoid clade
Multiclavula corynoides
M. vernalis
100
1 nucleotide substitution/100 sites

**Fig. 1.** Most likely phylogenetic tree for Omphalinoid mushrooms based on a combined nuclear LSU and ITS rDNA data set. Adapted from Lutzoni (1997, Fig. 7). Note the revised labelling of the clades proposed here and that "*wynniae*" and "*grossula*" are combined as *C. grossula*.

*"Chrysomphalina"* nom. invalid. (Haas,1962) was coined for two carotenoid forming taxa. The "type" *C. chrysophylla,* was retained in *Chrysomphalina* Clémençon (1982) when the name was validated, while the other, *Haasiella venustissima* (Fr.) Kotl. & Pouz., was excluded and treated in the genus *Haasiella* Kotlaba & Pouzar (1966); see also Kost (1986) and Chiaffi & Surault (1996). Neither of the two presently recognized *Haasiella* species have been sequenced, but it seems possible that *Chrysomphalina* species might be their closest allies, and if nested among them, the name *Haasiella* would have priority. Following a detailed anatomical study, Kost (1986) however, concluded they were not closely allied.

When *Chrysomphalina* was validated by Clémençon (1982), he included two species, the type, *C. chrysophylla*, and *Gerronema strombodes*, while excluding *H. venustissima*. As indicated above, *G. strombodes* is unrelated to *C. chrysophylla*. Additionally, the European concept of "*G. strombodes*" represented a misapplication of that name. *Gerronema strombodes* is restricted to eastern North America. The European taxon known to Clémençon as *"G. strombodes"* represents a different species, *G. xanthophyllum* (Bres.) Norvell et al., also a true *Gerronema* (Norvell et al. 1994; Birrer 2000). As characterized by Norvell et al. (1994), *Chrysomphalina* accommodates lignicolous, clampless, carotenoid forming, omphalinoid taxa with nonamyloid thin-walled spores, pachypodial subhymenia, and monomitic tissues.

*Chrysomphalina*, as thus defined, appears to be a monophyletic taxon allied firstly to a sister genus *Hygrophorus* Fr. (Moncalvo et al. 2000 & 2002), and possibly allied to other hygrophoroid genera (Lutzoni 1997; Moncalvo et al. 2000 & 2002). The genus *Hygrophorus* sensu stricto (e.g., *H. bakerensis* A.H. Smith & Hesler, *H. sordidus* Peck) is clearly a distinct lineage and genus, distinguished by a presumed obligate ectomycorrhizal symbiosis, absence of carotenoids (pigmented by sundry other pigments, Gill & Steglich 1987), possession of a different chemistry, and clamp connection formation. *Chrysomphalina* species have elongated basidia (Norvell et al. 1994) and because of the pachypodial subhymenium, a somewhat divergent lamellar trama, perhaps homologous to the divergent, slightly differently arranged lamellar tramas characterizing *Hygrophorus* sensu stricto.

The combined phylogenetic analyses by Lutzoni (1997) sometimes placed *Hygrocybe citrinopallida* (A.H. Smith & Hesler) Kobayasi (another hygrophoroid taxon) in proximity to *Chrysomphalina* (with weak support). The analyses by Moncalvo et al. (2000, fig. 2, clade "K") sometimes shifted it closer (also with weak support) to the lichenized omphalinas ("*Phytoconis*") and *Arrhenia* clade. With the addition of more genera, especially other hygrophoroid taxa, analysis of the most parsimonious trees found from heuristic searches **(MP)** and the bootstrap 50% majority rule consensus tree **(BS)** (Moncalvo et al, 2002) continues to support the taxon pair *Chrysomphalina-Hygrophorus*. *Hygrocybe* (Fr.) P. Kumm. (including its type *H. conica* (Schaeff.: Fr.) P. Kumm.) appears to represent a monotypic lineage with two fundamental subgeneric divisions, e.g., *H. cantharellus* (Schw.) Murr. & *H. miniata* (Fr.: Fr.) P. Kumm. [sect. *Coccineae* subsect. *Squamulose*], and *H. spadicea* (Fr.) P. Karst. & *H. conica* [sect. *Hygrocybe* subsect. *Hygrocybe*]. The surmised sister taxon to this monophyletic *Hygrocybe* clade is a well-supported clade (90% BS) with *Chromosera cyanophylla* (Fr.) Redhead et al. and the wayward *Hygrocybe citrinopallida*, also known as *Gliophorus citrinopallidus* (A.H. Smith & Hesler) Kovalenko (1999). *Chromosera* Redhead, Ammirati & Norvell (1995) is a recently described monotypic genus established to account for a species alternately known as *Mycena lilacifolia* (Peck) A.H. Smith in North America and *Omphalina cyanophylla* (Fr.) Quél. in Europe. This lignicolous species was clearly neither an *Omphalina* nor a *Mycena* (Pers.) Roussel, but interestingly enough, Kühner (1980) suggested that it belonged in *Hygrocybe* subg. *Gliophorus*, and called it *"Hygrocybe" cyanophylla* nom. inval. (see Redhead et al. 1995).

Both *Gliophorus* Herink and *Chromosera* are characterized by viscid stipes and pilei, and by bright pigments. *Gliophorus* species are terrestrial and their biological status remains uncertain. Another species, *G. laetus* (Pers.) Herink, appears on a largely omphalinoid clade (the *Phytoconis*, *Arrhenia*, and *Cantharellula-Pseudoarmillariella* lineage, discussed below), i.e., separate from *G. citrinopallidus*. Unfortunately, as the type for *Gliophorus*, *G. psittacinus* (Schaeff. Fr.) Herink, has not been included in any of the analyses, application of the generic name is unresolved. The name *Gliophorus* potentially could compete with *Chromosera*, or be applicable to a sister taxon. *Gliophorus psittacinus* is a terrestrial species with an unestablished biological role (?ectomycorrhizal). In the analyses by Moncalvo et al. (2000, 2002), there is weak bootstrap support linking the *Chromosera-Hygrocybe* clade to the *Chrysomphalina-Hygrophorus* clade together with *Humidicutis* (Singer) Singer, a third hygrophoroid genus. Bootstrap analysis (but not MP analyses) support the phylogenetic placement of *Humidicutis marginata* (Peck) Singer (type for that generic name) next to the *Chrysomphalina-Hygrophorus* clade. These results potentially bring into inferred evolutionary proximity, a group of taxa that form muscaflavin based pigments (as surmised from other chemically analyzed *Hygrocybe*) and other *Hygrophorus*, known to be able "to induce extradiol cleavage of L-DOPA leading to the formation of muscaflavin" (Gill & Steglich 1987, p. 86). *Humidicutis* is in part defined by the absence of clamp connections and is otherwise different because of pigment characters (see Singer 1986). There are some indications that the core of the hygrophoroid taxa (the classical "Hygrophoraceae"), are basal to the Agaricales (euagaric clade). In the analyses of a portion of the mt LSU rRNA gene by Bruns et al. (1998), representatives of *Hygrophorus* and *Hygrocybe* actually appeared outside of the depicted main agaric clade, whereas in the analyses by Hibbett et al. (2000), *Hygrocybe conica*, *Humidicutis marginata* (as *Hygrocybe marginata* (Peck) Murr.) and the two *Hygrophorus* species analysed by Moncalvo et al. (2000) were shown to be basal to the rest of the euagaric clade. In all analyses, the backbones of all resulting phylogenetic trees are weakly supported, except for those using fewer taxa combined with several genomic regions evolving at different rates (ITS region combined with LSU nuc rDNA in Lutzoni 1997). We regard the Hygrophoraceae s.l. and s.s. (whether or not recognized as a distinct taxon) to be among the Agaricales (euagarics). Future investigation of that traditional family should include *Chrysomphalina, Chromosera*, possibly *Haasiella*, and the two omphalinoid lineages "*Phytoconis*" (= *Lichenomphalia*, see below) and *Arrhenia* as emended below.

The primary goal of the study by Lutzoni (1997) was to investigate the phylogeny of lichenized omphalinas and their relationships to non-lichen-forming omphalinoid agarics. Four of the five sampled lichenized species (*Omphalina grisella* (P. Karst.) Moser, *O. hudsoniana* (Jenn.) Bigelow, *O. luteovitellina* (Pilát & Nannf.) M. Lange, and *O. velutina*

(Quél.) Quél.) formed a clearly defined, strongly supported (BS = 92-98%) monophyletic lineage. The fifth, *O. ericetorum* (Pers.: Fr.) Bigelow (see discussion on authorship below and synonymy with "*umbellifera*"), was inferred to be sister to this lineage in all three combined analyses of the ITS region with the LSU nuc rDNA, but the placement received weak support (BS < 50-70%; Lutzoni 1997: figs. 5 & 7). The sister group to the lichenized clade in the 1997 analyses was a nonlichenized, largely bryophilous group of omphalinoid-arrhenoid species, all with dark pigments. This sister relationship was supported by bootstrap support ranging from 70-83% when the ITS region was combined with LSU data (Lutzoni 1997). Deeply nested among the lamellate omphalinoid taxa were the reduced agarics, *Arrhenia auriscalpium* Fr. (type for *Arrhenia*), *Arrhenia lobata* (Pers.: Fr.) Redhead (type for *Dictyolus* Quél.), and *Phaeotellus griseopallidus* (Desm.: Fr.) Kühner & Lamoure. In a larger taxon sampling restricted to the LSU data (Moncalvo et al. 2000), this close relationship between lichen-forming omphalinas and the grey and grey-brown omphalinoid-arrhenoid clade continues to be detectable with even larger datasets (Moncalvo et al. 2002), but the exact relationship of the taxon labelled *O. ericetorum* (= *umbellifera*) became uncertain with regard to these two lineages because of the paucity of characters inherent to a single gene phylogenetic analysis for such a large taxon sampling. In the smaller taxon matrix, a third bryophilous omphalinoid clade identified by Lutzoni (1997; BS = 95-100%, Figs. 5 and 7) and labelled *"Clitocybe"* (i.e., *Omphalina pyxidata*, *O. rivulicola* (J. Favre) Lamoure, *Clitocybe lateritia* J. Favre) appeared to be a sister taxon to the *"Omphalina"*-*Chrysomphalina* clade, with bootstrap support in all combined analyses ranging from 52-83% (Lutzoni 1997, Figs. 5 and 7). However, support weakened when diluted by the addition of far more diverse taxa and when phylogenetic analyses were restricted to LSU (Moncalvo et al. 2000). The *O. pyxidata-C. lateritia* clade (in clade "J") no longer groups with any other identifiable former *Omphalina*. MP analysis using a far larger taxon sampling suggests a relationship both to the bryophilous genus *Rimbachia* Pat. (*R. bryophila* (Pers.: Fr.) Redhead) and (less closely) to "*Clitocybe*" *clavipes* (Pers.: Fr. ) P. Kumm. (a taxon which remained distantly located in Moncalvo et al. 2000, fig. 2). None of these were close to the core *Clitocybe* (Fr.) Staude (eg. *C. nebularis* (Batsch: Fr.) P. Kumm., *C. dealbata* (Fr.: Fr.) P. Kumm., *Lepista nuda*

(Fr.: Fr.) Cooke), which appear to be far more closely related to the former Lyophylleae (Hofstetter et al, in prep.).

The conserved lectotype for the generic name *Omphalina* Quél. is *O. pyxidata* (Greuter et al. 2000, p. 192), hence we will hereafter apply the generic name *Omphalina* to the presumably bryophilous clade centered around the type, *O. pyxidata*, and not refer to it as "*Clitocybe*" as it was tentatively labelled with a question mark by Lutzoni in 1997. Conservation of the lectotype for *Omphalina* ends decades of debate (Bigelow 1970, Donk 1962, Jørgensen & Ryman 1989, 1994, Lange 1981, Redhead & Weresub 1978, Redhead 1993, Redhead & Kuyper 1987, 1988, 1993, Singer 1962, 1975, 1986, Singer & Smith 1946), but with unanticipated repercussions. As thus defined and restricted, *Omphalina* is not congeneric with either the lichenized species or the grey-brown nonlichenized "omphalinas". Biologically, *Omphalina* (sensu conserved lectotype) occupies similar habitats and substrates as species in the *Arrhenia* lineage, but they differ in subtle pigmentation chemistry and topology (the presumed melanins are more reddish brown than grey brown, and the deeper tissues are pigmentless, i.e. whitish). Without sequence data as a guide, these differences would not normally be considered to be generically significant, especially when compared to far more conspicuous morphological differences. Nonetheless, they do appear to correlate with base-pair sequence data generated phylogenies.

A fungus identified as *Omphalina pyxidata* has been linked by Hornby & Ward (1995) to a sclerotium-forming, weak pathogen of turf grass roots. However, they reported unspecified genetic differences between herbarium specimens of *O. pyxidata* and the suspected causal agent; specimens were not retained (Hornby 1995, pers.com.). Additionally the pinkish-purple coloration of the basidiomata (illustrated in color) suggests that another fungus might be involved. Therefore, its generic identification remains ambiguous.

Notwithstanding the above report, *Omphalina pyxidata* has been regarded as a bryophilous fungus (Bigelow 1974, Lamoure 1974). Similarly *O. rivulicola* is bryophilous (Lamoure 1974). Together they form a bryophilous clade (Moncalvo et al., 2002). Sister to this bryophilous clade was one containing an unidentified *Clitocybe* sp. and *Clitocybe lateritia*. The latter grows with *Dryas* litter in alpine meadows (Lamoure 1972) and presumably is not bryophilous. In common with *O. pyxidata* and *O. rivulicola*, *C. lateritia* produces reddish brown melanin-like pigments, rather than the greyish pigments of the *Arrhenia* clade. We will return to the discussion of the *Omphalina* (*O. pyxidata* clade) further below.

The oldest available generic name for any of the other omphalinoid species that appear on the combined *Arrhenia*-"*Phytoconis*" clades is *Arrhenia* Fries (1849). *Arrhenia* was first erected for basidiomycetes characterized by nutant basidiomata with cantharelloid hymenia (Corner 1966, Høiland 1976, Pilát & Nannfeldt 1954). Later the genus was expanded to include species with pleurotoid basidiomata, incl. *Leptoglossum* and *Phaeotellus* (Aronsen 1992, Breitenbach & Kränzlin 1991, Courtecuisse 1986, Gulden 1987, Gulden & Torkelsen 1996, Kreisel 1987, Kühner & Lamoure 1972, Moser & Jülich 1997, Redhead 1984, Senn-Irlet 1987, Watling 1988, Watling & Gregory 1989). However, the delimitation from omphalinoid taxa has always been controversial (Gulden 1987, Høiland 1982, Lange 1981, Watling 1988), as has been the delimitation of *Arrhenia* from *Leptoglossum* (Corner 1966, Redhead 1984), including debatably classified species with centrally stipitate basidiomata, and cantharelloid hymenia. There is a complete transitional series of morphological features from gross omphalinoid to cyphelloid habit, and lamellate to merulioid to smooth hymenia. Based upon the deeply nested position of *Arrhenia* within the clade of more typically omphalinoid taxa (Lutzoni 1997, Moncalvo et al. 2000 & 2002) and the gradation of morphological features, we are now prepared to expand the coverage of the name *Arrhenia* to include omphalinoid, pleurotoid, nutant, and cyphelloid forms to this primarily bryophilous/phycophilous lineage with greyish melanized basidiomata. Invasion of dead moss cells has been documented (Hassel & Kost 1998), at least in the instance of the species with the most reduced basidiomata, *A. retiruga* (Bull.: Fr.) Redhead, a cyphelloid taxon and apparent necrotrophic parasite. Although described on old bovine dung, the grey-brown, clampless, cyphelloid fungus, *Glabrocyphella stercoraria* Barrasa, Esteve-Rav. & Sánchez (Barrasa et al. 1998), is best considered to be a species of *Arrhenia* perhaps associated with the algae also reportedly growing on the dung substrate. Notably, the possibility of microscopic moss protonema was not excluded. For now we are prepared to include the similar species, *Leptoglossum omnivorum* Agerer (1984), in *Arrhenia*, based in part on examination of the type. These cyphelloid and nutant taxa are morphologically terminal groups of the primarily dark grey "omphalinoid" group of species (cf. Lamoure 1975, Singer 1956).

The taxonomic question of whether or not to distinguish the lichenized *"Phytoconis"* generically from nonlichenized *Arrhenia* hinges in part on conveyance of information regarding phylogeny, biological status, and anatomy, and in part on nomenclature. It has previously been argued based upon anatomy and biology that the lichenized omphalinas should be recognized in a distinct genus (Kuyper 1986, 1994, 1995, Norvell et al. 1994, Redhead & Kuyper 1987, 1988). Lutzoni & Vilgalys (1995a) confirmed these results (BS = 75%, Figs. 2A) with a phylogenetic analysis restricted to morphological and anatomical characters. When combined with LSU data, the bootstrap value dropped slightly to 67% (Lutzoni & Vilgalys 1995a, Fig. 7). In the phylogenetic study with the most molecular characters (i.e., ITS region combined with LSU nuc rDNA, Figs. 5 and 7, Lutzoni 1997) the three combined analyses consistently revealed the lichenized omphalinas as a monophyletic entity with bootstrap support as high as 70%. Other studies with broader taxon sampling but restricted to the LSU (Moncalvo et al. 2000, & 2002) did not have sufficient data to provide bootstrap values (< 50%) for the phylogenetic placement of *"Omphalina" ericetorum/umbellifera* specifically on this clade; rather it is only placed in proximity. The latter studies do not confirm nor contradict the monophyly of the lichenized omphalinas. Therefore, our best phylogenetic estimates (i.e., those with the highest level of confidence) come from the phylogenetic analyses of morphological data alone (BS = 75%; Lutzoni & Vilgalys, 1995a) and from the phylogenetic analyses with the most molecular data, i.e., combined ITS with LSU data set (BS up to 70%; Lutzoni 1997). Both analyses independently supported the monophyly of the lichen-forming omphalinas. None of the competing phylogenetic relationships for the paraphyly or polyphyly of the lichenized omphalinas received bootstrap support > 50%. We therefore opt to recognize the lichenized omphalinoid agarics as a distinct genus.

Unfortunately, all three applicable validly published generic names – *Phytoconis*, *Botrydina,* and *Coriscium* – have been placed on a list of rejected names (see Gams 1995; Greuter et al. 2000) and hence are unavailable. This regrettable nomenclatural consequence results from not applying the same standards to basidiolichen generic names as is done for ascolichen generic names. To quote from the report of the Committee for Fungi (Gams 1995, p. 413), "By consequence those accepting the lichenized species as a separate genus are instructed to describe and name it as new, based upon holomorphic material, rather than using the anamorph name *Phytoconis* which was taken up by Redhead & Kuyper (in Mycotaxon 31: 321-323. 1988), following the letter (but not the intention) of Art. 59." Therefore, despite the recognition of a distinct wholly lichenized genus and acceptance of the name "*Phytoconis*" by agaricologists (Clémençon 1997, Collin & Lauron 1994, Grgurinovic 1997, Kuyper 1995, Nezdoiminogo 1997, Norvell et al. 1994, Redhead & Kuyper 1987, 1988, Romagnesi 1992, Watling 1988), the name *Phytoconis* is no longer available. We therefore name a "new" genus, *Lichenomphalia* gen. nov. (see below).

*Lichenomphalia* appears to have evolved from a bryophilous or phycophilous ancestor as suggested by Redhead & Kuyper (1987) and confirmed by Kranner & Lutzoni (1999). Using *Omphalina* as a model system (cf. Lutzoni & Vilgalys 1995a & b, Lutzoni 1997, Lutzoni & Pagel 1997), Kranner & Lutzoni (1999) noted that among analyzed *Lichenomphalia* (as lichenized *Omphalina*) and the non-lichenized sister genus *Arrhenia* (as *Arrhenia*, *Omphalina*, and *Phaeotellus*), *L. umbellifera* comb. nov., *Arrhenia velutipes* comb. nov., and *A. epichysium* comb. nov. (see below), are the most basal and exhibit the slowest evolutionary rate changes in their respective clade. Therefore, they are the closest living phenotypic representations of the common ancestor that the non-lichenized *Arrhenia* and lichenized *Lichenomphalia* share. All three species are bryophilous and/or phycophilous. Kranner & Lutzoni (1999, Fig. 1) identified three major predispositions for a successful transition to a lichenized state: 1) high phenotypic plasticity/broad ecological amplitude, 2) low fungal virulence/high photobiont infection resistance, 3) desiccation and sun irradiation tolerant/efficient DNA repair mechanisms. They further noted that *L. umbellifera* (as *O. ericetorum*) is the most plastic species of the lichenized *Omphalina* group, as well as the most common, the most broadly distributed, and with the broadest range of substrates. This fulfils the first requirement. The study of predacious fungi lysing colonies of algae, bacteria, pollen, and/or yeasts (Barron 1988, Hutchinson & Barron 1996, 1997a, b) using modified hyphae remarkably similar to those forming the thalli of these and other basidiolichens (Oberwinkler 1970, Redhead & Kuyper 1987), suggests a physical mechanism and chemo-attractant response to algal colonies that provided an opportunity for the lichenization process to begin. It has also been shown that *Coccomyxa icmadophilae* Jaag, the alga entrapped by *Lichenomphalia*, forms cell walls resistant to lysolytic enzymes (Honegger & Brunner 1981). Thus, the combined low-level parasitism and resistance to enzymatic lysing fulfils the second requirement.

Lutzoni & Pagel (1997) outlined phenomena supporting fulfilment of the third requirement, i.e., strong positive selection in the lichenized omphalinas toward replacing one of two adjacent thymines by another nucleotide to prevent thymine dimerization. Given the poikilohydric and heliophylic nature of most lichens, lineages tolerant to oxidative stress caused by desiccation and sun irradiation, and/or with efficient DNA repair mechanisms would be more suited to forming a successful mutualistic association with terrestrial cyanobacteria or green algae. Again, *L. umbellifera* appears to exhibit more ancestral features because its thallic mycelium is broader and not as thick-walled (Redhead & Kuyper 1987, as *Botrydina botryoides* (L.) Redhead & Kuyper) and therefore, presumably less tolerant of radiation and dehydration damage, it occupies wetter habitats on average, and its basidiomata are less protected by strong pigments (either dark melanins or the bright yellow-orange uncharacterized pigments).

We anticipate that the as-yet unsequenced and rare genus, *Semiomphalina* Redhead (1984), a nutant, pale arrhenioid but lichenized basidiomycete (known only from the type collection of *S. leptoglossoides* (Corner) Redhead ) will prove to be a sister taxon to *Lichenomphalia*. Its stipe and thallus resemble those of *L. umbellifera*.

# Other omphalinoid/clitocyboid genera

In both the final BS and MP trees generated for the Agaricales analyses (Moncalvo et al. 2002), a moderately supported clade (49% BS) bearing *Cantharellula umbonata* (J.F. Gmelin: Fr.) Singer and *Pseudoarmillariella ectypoides* (Peck) Singer (types of their respective generic names) appears together on a weakly supported clade bearing the *Arrhenia* clade (77% BS) and all sampled *Lichenomphalia* as defined above (*L. velutina*, *L. alpina*, *L. hudsoniana* - on one clade with 77% BS; and *L. umbellifera* separately), and also *Gliophorus laetus*. Anatomically, the *Cantharellula-Pseudoarmillariella* clade is generically easily distinguished from nonamyloid-spored *Arrhenia*, *Lichenomphalia*, and *Gliophorus laetus* by the formation of amyloid spores.

*Pseudoarmillariella ectypoides* is lignicolous (a white rot agent ?) and has a scaly, orangish brown pileus. *Cantharellula umbonata* is primarily bryophilous, but occasionally remains in residual populations in young conifer forests with recently, closed canopies where populations of host mosses have died (Redhead & Malloch 1986). Species in both *Pseudoarmillariella* and *Cantharellula* share characters such as forked lamellae, reddish brown bruising reactions of the hymenium, and similarly arranged subhymenial elements, i.e., "subirregularly intermixed-subramose" elements "strongly interlaced-curved in all directions and therefore at times appearing cellular" (Singer 1986 [when comparing *Pseudoarmillariella* to *Cantharellula*]). Previously Singer (1951b) had treated both type species in one genus, *Cantharellula*. The generic name *Pseudoarmillariella* (Singer) Singer was in fact an elevation in status of *Cantharellula* subg. *Pseudoarmillariella* Singer. Interestingly, Bigelow (1982) had transferred *P. ectypoides* to *Omphalina* sensu Bigelow (ca. = *Gerronema* sensu Singer), but he maintained the distinction between it and *Cantharellula* (Bigelow 1975). We maintain the separate generic identities for *Pseudoarmillariella* and *Cantharellula* as proposed by Singer (1956) and outlined by Singer (1986), while still acknowledging the close relationship between them. As noted by Norvell et al. (1994), *Pseudoarmillariella* possesses two pigment classes and forms a thickening hymenium, in addition to being a wood decay fungus.

*Clitocybe clavipes*, which occurs on a weakly supported clade with *Rimbachia* and *Omphalina* sensu lectotype (Moncalvo et al, 2002, fig. 2), presents a dilemma because it seems to represent a distinct genus, phylogenetically more closely related to the type of *Omphalina* than the type of *Clitocybe* (see discussion below). The sequence data are unlike other traditional clitocyboid taxa, most of which prove to be more closely related to the Lyophylleae (Moncalvo et al. 2002; Hofstetter et al. in prep.). *Clitocybe clavipes* is uniquely characterized among clitocyboid taxa by the formation of coprine-like compounds (Cochran & Cochran 1978, Yamaura et al.1986) and by ultrastructurally minutely roughened basidiospores (Pegler & Young 1971, Bigelow 1981, 1982) compared to smooth-spored *Clitocybe* or echinate-spored *Lepista* (Fr.) W.G. Smith. *Clitocybe clavipes* also produces a novel class of tyrosine kinase inhibitors, named the clavilactones (Cassinelli et al. 2000). The combination of significantly different sequence data from other "*Clitocybe*", and ultrastructurally distinctive spores suggest that "*C. clavipes*" has been incorrectly classified as a *Clitocybe*. We therefore propose to recognize a distinct genus, *Ampulloclitocybe* (type = *A. clavipes*, see below) for the species. Strict consensus of the 5,000 most parsimonious trees found (MPF) by Moncalvo et al. (2002) place *Ampulloclitocybe clavipes* next to *Rimbachia bryophila*, which in turn is sister to the *Omphalina* (*O. pyxidata*) and *Clitocybe lateritia* clades.

The phylogenetic proximity of the fungus, *Ampulloclitocybe clavipes* to a fungus named *Clitocybe lateritia* (Moncalvo et al. 2002), and the phylogenetically distant taxa named *Clitocybe dealbata*, *C. odora* (Bull.: Fr.) P. Kumm., *C. ramigena* Bigelow, *C. connata* (Schum.:Fr.) Gillet (=*Lyophyllum connatum* (Schum.: Fr.) Singer), *C. glacialis* Redhead et al. (=*Lyophyllum montanum* A.H. Smith), *C. nebularis* (=*Lepista nebularis* (Batsch: Fr.) Harmaja), and *C. nuda* (Fr.: Fr.) Bigelow & A.H. Smith (=*Lepista nuda*), begs a question regarding application of the name *Clitocybe* (Fr.) Staude and its lectotypification. The lectotypification of *Clitocybe* has been as heatedly debated as has lectotypification of *Omphalina*, and the topic remains unsettled (Bigelow 1965, Clements & Shear 1931, Donk 1949, 1962, Harmaja 1969, 1974, Horak 1968, Imai 1938, Korf 1988, Kühner 1980, Kuyper 1982, 1995, Rauschert 1986, Singer 1936, 1951b, 1962, 1975, 1986, Singer & Smith 1946). The choice of *C. clavipes* (type of our

*Ampulloclitocybe*) as lectotype of *Clitocybe* by Bigelow (1965) is noteworthy, but must be dismissed because of the earlier lectotypifications (Greuter et al. 2000, Art. 9.17). The primary division of thought is split between support for *Agaricus nebularis* Batsch: Fr. versus *Agaricus infundibuliformis* Schaeff. (= *Agaricus gibbus* Pers.: Fr. according to Singer 1986; = *Agaricus flaccidus* Sow.: Fr. according to Fries 1821 and Kuyper 1995). Donk (1962) reviewed the various typifications proposed up to 1962. The earliest lectotypification of the generic level name "*Clitocybe*" [with variously attributed authorship all involving Fries and his "tribus" as basionym] choosing *A. nebularis*, was by Earle (1909) followed by Murrill (1916), both following the American Code of Nomenclature. Such choices made using the American Code may be superseded (Greuter et al. 2000, Art. 10.5b). Using a misspelled epithet with incorrect, non-existent authority, Clements & Shear (1931) selected "*C. infundibulis* (Schaeff.) Fr." Despite the errors, their intent was clear, but because there is, in fact, no such species, their lectotypification [for priority purposes] is rejected. Singer (1936) and Singer & Smith (1946) were the next to name a [lecto-]type, namely *Clitocybe infundibuliformis*, but for either *Clitocybe* "Fr." or *Clitocybe* "(Fr.) Quél." However, the names *Agaricus infundibuliformis* Schaeff. and *A. infundibuliformis* Bull., were both treated as synonyms of *Agaricus flaccidus* Sow.:Fr. (an accepted, named species) by Fries (1821). Technically the choice of *A. infundibuliformis* is rejected simply because in the protologue of the basionym for the generic name, i.e. *Agaricus* "tribus" *Clitocyb*e Fr. (1821: 78), that particular species binomial was not used for a named, recognized species. The first choice of a recognised, named species – both in Fries' "tribus" and when elevated by generic status (by Staude) – was Donk's (1949) selection of *A. nebularis*. Nonetheless, unless conserved, lectotypification of *Clitocybe* (Fr.) Staude will remain debatable. A proposal to conserve *Clitocybe* (Fr.) Staude with a conserved lectotype, *Agaricus gibbus* Pers.: Fr., by Rauschert (1986) was rejected (Korf 1988) simply because the proposal lacked detail, and unfortunately the proposer had subsequently died. For our purposes, we accept *C. nebularis* (cf. also Kuyper, 1992). The generic taxonomic delimitations (*Clitocybe* versus *Lepista* and various Lyophylleae) and precise phylogenetic placement of *Clitocybe* (typified by *C. nebularis*), which is phylogenetically distant from the clade with *Omphalina* (*O. pyxidata*), *"Clitocybe" lateritia*, and *Ampulloclitocybe clavipes*, as well as the clade with *Arrhenia* and *Lichenomphalia*, are the subjects of other manuscripts in this series. At this time we lack sufficient confidence and information to assign a different generic name to *Clitocybe lateritia*. Possibly it will be assigned to the reconstructed genus *Omphalina*.

For an interim key to the omphalinoid genera discussed above we refer to the key in Norvell et al. (1994), replacing the name "***Phytoconis***" with ***Lichenomphalia***, and replacing couplet **#8** (leading to *Omphalina*, *Clitocybe*) with the following couplets.

**8.** Bryophilous or phycophilous (sometimes appearing terrestrial or lignicolous due to sparse growth of associated algae or bryophytes), never on sound clean wood or conspicuously causing white or brown wood rots [with incrusting pigments, odor never farinaceous]; reduced forms exhibit hymenial folds and wrinkles, may lack stipes, may be nutant or pendant [see also key to *Arrhenia* by Redhead, 1984] . . . . **9**
**8.** Terrestrial or lignicolous, not dependent on living algae or bryophytes; if on wood, mycelium clearly penetrating and decaying wood [easily cultured on standard general media from spores, odor sometimes farinaceous or strongly aromatic, many species large and not omphalinoid] . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . **10**
**9.** Coloration of pilei and stipes grey, blackish, or bluish, and brown-grey, with slightly paler but similarly colored hymenia (lamellae or folds), or for some sphagnicolous species pilei scaly centrally with darkly incrusted pigments but pileus tending to be beige or tan and then lamellae are pallid; clamps present or absent, stipes and/or regular lamellae present or absent . . . . . . . . . . . . . . . . . . . . . . ***Arrhenia***
**9.** Coloration of pilei and stipes reddish brown (rusty, vinaceous brown, orangish brown) and lamellae contrastingly much paler (i.e. pallid, whitish, pastel), always smooth and not scaly; clamp connections present; lamellae always well-formed . . . . . . ***Omphalina***
**10.** Basidiomata nonhygrophanous, with markedly darkened fleshy pileus and fleshy bulbose-based stipe contrasting with the whitish cream lamellae; clamps present; pigments intracellular; spores smooth (light microscopy) but ultrastructurally rugose (SEM), not cyanophilous or congophilous, white in prints; producing coprine-like poisonings

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ***Ampulloclitocybe***
**10.** Not with above combination other unresolved clitocyboid genera.

Note: It should be recognized that the reclassification based upon phylogenetic studies is a work in progress.

## New genera and new combinations

***Ampulloclitocybe* gen .nov.**
*Basidiomata clitocybiformis. Non lichenisatus. Trama lamellarum bidirectionalis, hyphis fibulatis, cystidia nulla. Sporis albis, microrugosis, acyanophilis, inamyloideis.*
Type: ***Ampulloclitocybe clavipes* (Pers.: Fr.) comb. nov.** Basionym: *Agaricus clavipes* Pers., Syn. meth. Fung. p. 353. 1801. (*A. clavipes* Pers.: Fr., Syst. mycol. 1: 86. 1821)

***Lichenomphalia* gen nov.**
*Basidiomata omphaliformis. Lichenisatus. Trama lamellarum bidirectionalis, hyphis defibulatis, cystidia nulla. Sporis albis, inamyloideis.* Type: ***L. hudsoniana*** (see below).
= *Phytoconis* Bory 1797 nom. rej. (Greuter et al. 2000)
= *Botrydina* Bréb. 1839 nom. rej. (Greuter et al. 2000)
= *Coriscium* Vain. 1890 nom. rej. (Greuter et al. 2000)
= *Omphalina* sect. *Defibulatae* Singer 1975
= *Gerronema* sect. *Phycophila* Clémençon 1982
= *Clitocybe* subsect. *Defibulatae* (Singer) Bigelow 1985

## *Lichenomphalia* species

***L. alpina* (Britzelmayr) comb. nov.** Basionym: *Agaricus alpinus* Britz., Ber. Naturw. Ver. Augsburg 30: 13. 1890.

Comments: Synonymous names are: *Cantharellus dovrefjeldiensis* P. Henn. & Kirschst., *Agaricus umbelliferus* var. *flavus* Sommerf., *Omphalia flava* (Sommerf.) Möller, *Omphalia luteovitellina* Pilát & Nannfeldt (see Jørgensen & Ryman 1989b).

Application and synonym of the name *Agaricus alpinus* has been disputed (Redhead & Kuyper 1987, Jørgensen & Ryman 1989b). The designation of Britzelmayr's plate by Jørgensen & Ryman (1989b) as lectotype did little to resolve the controversy. **Therefore, we hereby designate an epitype for the name *Agaricus alpinus* Britz., i.e. the type for *Omphalia luteovitellina*.** If we do not do so, thereby fixing application of the name to this taxon, then we are forced to adopt *Cantharellus dovrefjeldiensis* as the next available name (Jørgensen & Ryman 1989b). We cannot fully explain the subtle discrepancies, such as paler stipe, and perhaps slightly hollowed stipes recorded by Britzelmayr (1890), neither of which is normal for the taxon accepted here. Neither discrepancy appeared to bother Jørgensen & Ryman (1989b), nor the fact the species as accepted here has not been independently documented in the region where Britzelmayr collected in the past century. However, Favre (1955) found this species, reported as *Omphalia flava*, in alpine regions of the Swiss Alps, and therefore it is possible that Britzelmayr had found it in the somewhat nearby Bavarian alpine regions. The synonym proposed by Redhead & Kuyper (1987), i.e. placement of *Agaricus alpinus* Britz. in synonymy with *Endocarpon viride* Ach. (= *Botrydina viridis* (Ach.) Redhead & Kuyper = *Lichenomphalia hudsoniana*), is rescinded simply for convenience and to reach consensus with Jørgensen & Ryman (1989b).

The report of *Omphalina alpina* (Britzelmayr) Bresinsky & Stangl (with *Omphalia luteovitellina* Pilát & Nannfeldt (1954) in synonymy) from Yunnan was based upon a fungus reportedly with clamp connections (Horak 1987: 179). If the presence of clamp connections is true, that fungus cannot be conspecific with any *Lichenomphalia*.

***L. aurantiaca* (Redhead & Kuyper) comb. nov.** Basionym: *Botrydina aurantiaca* Redhead & Kuyper, Arctic & Alpine Mycology II, p. 334. 1987. Plenum Press, NY.

***L. chromacea* (Cleland) comb. nov.** Basionym: *Omphalia chromacea*, Trans. & Proc. Roy. Soc. South Australia 48: 239. 1924.

Comments: An incorrect basionym citation was given by Redhead & Kuyper (1987, 1988) and corrected by May & Wood (1995). Isotype material at BPI was recorded by Redhead & Kuyper (1988).

***L. grisella* (P. Karst.) comb. nov.** Basionym: *Omphalia grisella* P. Karst., Medd. Soc. Fauna Flora Fennica 16: 92. 1890 [ut "(Weinm.?) n. sp."].

***L. hudsoniana* (Jennings) comb. nov.** Basionym: *Hygrophorus hudsonianus* Jennings, Mem. Carnegie Mus. III, 12: 2. 1936.

Comments: Synonymous names are: *Endocarpon viride* Acharius [thallus only, rejection of this name has been recommended - cf. Gams (1995), and is somewhat listed as such in Appendix IV of the Code (Greuter et al., 2000: 394) as type for the rejected generic name *Coriscium* Vain.], *Verrucaria laetevirens* Borrer [thallus only], *Omphalia luteolilacina* Favre (fide Redhead & Kuyper 1987), but not *Agaricus alpinus* Britz.(see discussion above).

***L. lobata* (Redhead & Kuyper) comb. nov.** Basionym: *Botrydina lobata* Redhead & Kuyper, Arctic & Alpine Mycology II, p. 334. 1987. Plenum Press, NY.

***L. umbellifera* (L.: Fr.) comb. nov.** Basionym: *Agaricus umbelliferus* L., Species plantarum p. 1175. 1753; *Agaricus umbelliferus* L.: Fr., Elenchus fungorum, p. 22. 1828.

Comments: Synonymous names are: *Byssus botryoides* L. [thallus only - see Redhead & Kuyper 1987, Jørgensen et al. 1994], *Botrydina vulgaris* Bréb. [thallus], *Agaricus pseudoandrosaceus* Bull., *Agaricus nothus* Gmelin, *Agaricus ericetorum* Pers.: Fr., *Agaricus valgus* Holmskjold, *Merulius turfosus* Pers., *Omphalia luteola* Peck, *Omphalia sphagnophila* Peck, *Omphalina fulvopallens* P.D. Orton (see Redhead & Kuyper 1987, 1988, Kuyper 1995, except for their discussion on A. *umbelliferus* as is detailed below).

Following the extensive review of names and types discussed by Redhead & Kuyper (1987), Jørgensen & Ryman (1989a & b, 1994) published nomenclatural reviews of their own and designated several neo- or lectotypes, some placing names in conflict with those adopted or rejected by Redhead & Kuyper (1987), and others supporting the interpretations by Redhead & Kuyper (1987, 1988). The most contentious and destabilizing conflict revolves around the choice of *Agaricus ericetorum* Pers.: Fr. versus *Agaricus umbelliferus* L.: Fr. Jørgensen & Ryman (1989b) incorrectly claimed ***(i)*** that Redhead & Kuyper (1987) had overlooked the fact that Fries (1821) "only cites his own Obs. mycol. 1 p. 87" and ***(ii)*** that Fries did only that. In fact Fries (1821: 509) specifically gives the authority as "*ericetorum* P. A. S." **not** "Fr." as he did for his own named species ( "P." = Persoon and "A.S." = Albertini & Schweinitz). These facts were **explicitly** noted by Redhead & Kuyper (1987: 326-327). Notwithstanding all previous arguments published, we note that in the latest Code (Greuter et al. 2000: 30, Art. 15.1 Ex. 1) the two names are cited as "*Agaricus ericetorum* Fr." and "*A. umbelliferus* L." which suggests that "*Agaricus ericetorum* Fr.: Fr." is a quasi-conserved (i.e. unlisted in any appendix of the Code) name with that authority, rather than "*Agaricus ericetorum* Pers.: Fr." This makes the citation of "*Agaricus ericetorum* Fr." in the Code an ambiguous and poor example. We further note that changes in articles and wording of the Code (Greuter et al. 2000) again alter nomenclatural conclusions reached using earlier Codes by various authors. Specifically, Art. 7.5 now states, "Automatic typification does not apply to names sanctioned under Art. 15." Hence, *Agaricus ericetorum* of Fries (1821) would not be automatically typified by the type of *A. pseudoandrosaceus* Bull., as it would have been under the Code in effect (Voss et al. 1983) when Redhead & Kuyper (1987) interpreted the names.

What, then, are the lectotypes for the names *Agaricus umbelliferus* and *Agaricus ericetorum*, how many names with different authorities are there, and – as ultimately typified – are they taxonomic synonyms? Or in other words, how many homonymic names called *Agaricus ericetorum* are there, and which is sanctioned by Fries' (1821) usage of that binomial?

*Agaricus ericetorum* Pers. (1796) was first introduced as a binomial citing the earlier named *Agaricus pseudo-androsaceus* Bull. pl. 276 (Bulliard 1786) in synonymy. *Agaricus ericetorum* Pers. is therefore illegitimate (Art. 52.1), unless it is considered sanctioned (Art. 15) or conserved (Art. 14). The concepts of both Bulliard (1786) and Persoon

(1796) were broad and as currently recognized included more than one species. Redhead & Kuyper (1987: 329) lectotypified *Agaricus ericetorum* Pers. and *Agaricus pseudo-androsaceus* Bull. by designating the same illustration on Bulliard plate no. 276, specifically choosing the central figure of pale, rather than greyish agarics depicted on a moss cushion, and thus exclude the greyish forms. This typification of *Agaricus pseudo-androsaceus* Bull. was uncontested and accepted by Jørgensen & Ryman (1989a: 140). All authors agreed it was applicable to the species represented by Lundell & Nannfeldt, Fungi exsicc. Suec. No. 1753.

Singer (1961: 23) had previously selected a specimen of *A. ericetorum* from Persoon's herbarium in Leiden (**L** 910.256-1888) as "lectotype" for *Agaricus ericetorum* "Pers. ex Fr.", but it can at best be considered to be an epitype (or neotype) because there is no date on the specimen and it was not seen by Bulliard who coined the earlier included synonym, *A. pseudo-androsaceus*. Furthermore, unless *Agaricus ericetorum* Pers. is considered sanctioned, Art. 7.5 dictates that such illegitimate names are to be "...automatically typified by the type of the name which ought to have been adopted under the rules...." if the author did not designate a type (which Persoon did not do). Therefore, the type of *Agaricus ericetorum* Pers. (1796) is automatically the type of *Agaricus pseudo-androsaceus* Bull., specifically the central figure on Bulliard's (1786) plate 276. Lange (1981: 693) also dismissed Singer's (1961) typification because, "Singer's notes on the specimen do, however, not indicate that it has the qualities of a lectotype." We suppose this refers to the lack of a date. Lange (1981), however, did not offer an alternative type for the name *Agaricus ericetorum* Pers. Instead he sought to typify *Agaricus ericetorum* "Fries" as distinct from *Agaricus ericetorum* Pers. This is illogical if the type method is followed, but understandable given the confusion and broad application of the name to several species. Singer (1962) identified Persoon's specimen (**L** 910.256-1888, proposed as type of *A. ericetorum* Pers.) with the well known, common, palely pigmented species he called *Omphalina ericetorum,* even while placing the name *O. umbellifera* in synonymy. Jørgensen & Ryman (1989a: 140) concurred with the taxonomic identification. The Persoon specimen and the lectotype for both *A. pseudo-androsaceus* Bull. and *A. ericetorum* Pers. are considered to be conspecific.

However, drawing upon work later reported by Singer & Clémençon (1973), Singer (1975) re-interpreted the type for *Omphalina* Quélet as being *Omphalina umbellifera* sensu Quélet, and therefore initiated a schism of the treatment of *Omphalina* in the literature wherein *Agaricus ericetorum* "Fr. ex Fr." ended up in his genus *Gerronema*, but *Agarius ericetorum* "Pers."was treated as synonymous with both "*O. rustica*" and "*O. umbellifera* (L. ex Fr.) Quél." as well as with "*O. pseudoandrosaceous*". This contrasted with his earlier assertion the Persoon specimen was typical *O. umbellifera*, which all other authors considered to be synonymous with the species he was then calling *Gerronema ericetorum*. In his 3rd edition of **The Agaricales in Modern Taxonomy**, Singer (1975) proposed retention of the generic name *Omphalina* Quél. after having moved its type (as he accepted it in the 2nd edition, Singer 1962) to *Gerronema* (see also Singer 1970). This massive confusion caused by Singer's flip-flop application of the epithet "*umbelliferus*" and the lack of any single overlapping species between *Omphalina* sensu Singer (1970, 1975) and *Omphalina* sensu Bigelow (1970) led Redhead & Weresub (1978) to try to disentangle the synonymy and typifications of *Omphalina*. Together these publications precipitated the discussion by Lange (1981).

In the absence of conserved types for any of the species names, despite long debate, the typifications must again be reconsidered in light of revised wording of the Code (Greuter et al., 2000). Art. 7.8 currently states, "The typification of names adopted in one of the works specified in Art. 13.1(d), and thereby sanctioned (Art. 15), may be effected in the light of anything associated with the name in that work." Lange (1981: 695) sought to neotypify *Agaricus ericetorum* "Fr. ex Fr." with Lundell & Nannfeldt, Fungi exsicc. Suec. No. 1753 (**C**). Jørgensen & Ryman (1989a) noted that the specimen could not be a neotype because original material existed, namely illustrations cited by Fries (1821). They later (Jørgensen & Ryman 1994: 254) selected Tab. 1015, *ut "Agaricus niveus"* (Vahl 1790), as lectotype, formally epitypifying it by a specimen Lundell & Nannfeldt, Fungi exsicc. Suec. No. 1753 in herbarium **UPS** (rather than in **C** as was suggested by Lange 1981). The species represented by this specimen (to judge by all accounts on portions in other herbaria, e.g., **C** & **DAOM**), is conspecific with the species represented by the lectotype of *A. ericetorum* Pers. They are the same if the type method is followed. If they are the same, it cannot be argued that there is both an *Agaricus ericetorum* Pers. and an *Agaricus ericetorum* "Fr." If they are conspecific, and the one name is based on the other name, logically and nomenclaturally they must have the same lectotype. Fries (1821: 509) himself attributed the name to Persoon. Redhead & Kuyper (1987: 329) had selected the earliest lectotype for *Agaricus ericetorum* of Fries (1821) as well as of *Agaricus ericetorum* Pers. and *A. pseudo-androsaceus* Bull. This predates the selection of lectotype by Jørgensen & Ryman (1989a). The selection of an epitype by Jørgensen & Ryman (1994), however, is uncontested. It clearly is applicable to the name *Agaricus ericetorum* Pers.: Fr.

Controversy continued to dog the typification of *Agaricus umbelliferus* L. and *Omphalina* Quélet (Jørgensen & Ryman 1989a, b, Lange 1981, Redhead 1993, Redhead & Kuyper 1987, 1988, 1993, Singer 1986). We note that subsequent changes in the Code now allow different interpretations from those allowed in the 1980's. In particular, Art. 13.(d) does not disallow lichenized fungi from having sanctioned names, and as noted above Art. 7.8 state, "The typification of names adopted in one of the works specified in Art. 13.1(d), and thereby sanctioned (Art. 15), may be effected in the light of anything associated with the name in that work." This would allow for the rejection of the proposed lectotype of *Agaricus umbelliferus* L. by Redhead & Kuyper (1987, 1993), by the fact that Fries (1821) placed that proposed "lectotype" in another species. This in turn allows us to accept the lectotypification proposed by Jørgensen & Ryman (1989a), namely an unpublished original illustration by Rudbeck in the year 1695, apparently available to Linnaeus, which has been posthumously reproduced and published (Rudbeck 1987). A change in the wording of Art. 9.2 (Note 2) regarding "original material" nullifies the nomenclatural argument put forward by Redhead & Kuyper (1993) against this typification. We also accept the same epitype as that for the name *Agaricus ericetorum* Pers.: Fr., proposed by Jørgensen & Ryman (1994), i.e., Lundell & Nannfeldt, Fungi exsicc. Suec. No. 1753, herb. **UPS**. These lecto- and epi-typifications effectively make *Agaricus umbelliferus* L.: Fr. synonymous with *Agaricus ericetorum* Pers.: Fr. It is hoped that this compromise resolves and ends the 250-year old controversy over these names. Among sanctioned names, *Agaricus umbelliferus* has priority (Gams &

Kuyper 1984) and its lichenized status no longer nomenclaturally affects its availability.

***L. velutina*** **(Quél.) comb. nov.** Basionym: *Omphalia velutina* Quél., C.R. Ass. franç. Av. Sci. (Grenoble, 1885) 14: 445. 1886.

Comments: The following names represent taxa in a species complex, characterized by greyish basidiomata with incrusting pigments, clampless hyphae, velutinous stipes, elongated basidiospores, and a thallus consisting of numerous loose globose *Phytoconis*-like "goniocysts (cf. Serusiaux 1985)" linked by characteristically very narrow hyphae (1-)2(-3) $\mu$m diam (see Redhead & Kuyper 1987). They are considered to be synonymous at a species level, although a phylogenetic study by Lutzoni (1997) suggests that more than one species might be recognized molecularly in this complex, hence our recognition of *L. grisella*:

?= *Omphalina oreades* Singer and its nom. nov. *Clitocybe albimontana* Bigelow (see discussion in Redhead & Kuyper 1987).

?= *Omphalina pararustica* Clémençon (fide Kuyper 1995). Note: said to differ from *L. velutina* by presence of 4-spored basidia.

?= *Clitocybe borealis* Bigelow and its nom. nov. *Clitocybe kemptonii* Bigelow [Holotype at MICH examined by SAR and thalli confirmed; V. Wells & P. Kempton #2298, 13 Jul 1966, Eklutina L., Alaska, USA; also examined were specimens cited by Bigelow (1985), i.e. Wells & Kempton #2410, Alaska, conspecific; A.H. Smith # 55960, California, conspecific; and a specimen identified as *C. kemptonii* by H.E. Bigelow at MICH but not cited by him, i.e. A.H. Smith #80399, 31 Aug 1971, alpine meadow, Davos-Platz, Switzerland].

**Excluded from "C. kemptonii":** Wells & Kempton #2409, Alaska - a clamped, nonlichenized omphalinoid *Arrhenia* cited by Bigelow (1985) as *C. kemptonii*.

?= *Omphalina defibulata* Singer 1952 [Isotype at MICH examined by SAR and thalli confirmed; R. Singer M355, 10 Feb 1950, Tierra del Fuego, Rio Grande, Estancia, Nueva, Argentina]

?= *Clitocybe solumophila* Bigelow 1983 [Holotype at MICH examined by SAR and thalli confirmed; A.H. Smith #8501, 6 Nov 1937, Siskiyou Natl. Forest, Siskiyou, California, USA]

?= *Clitocybe payettensis* Bigelow 1983 [Holotype at MICH examined by SAR and thalli confirmed; A.H. Smith #44296, 28 June 1954, Lake Fork Creek, Valley Co., Idaho, USA]

?= *Omphalina meridionalis* Contu & La Rocca, Fungi non delineati 9: 32-33. 1999. [Holotype re-examined and reinterpreted as a clampless species by Barrasa & Esteve-Raventós 2000. Confirmation of the clampless state was made on a later collection kindly collected, identified and supplied by Marco Contu for deposit in DAOM (#229481), Italy, Sardinia, Trinita, d'Agultu, loc. Vignola, 18 Feb. 2001. However, this sample has zebra-striped, finely incrusted pigments contrary to the smoothly pigmented hyphae reported by Barrasa & Esteve-Raventós (2000). It also has the narrower thallic hyphae typical for the *L. velutina* complex. It remains debatable as whether or not and how to distinguish this taxon from *L. velutina* or other named 'species' in the complex. The other *Lichenomphalia* species (*L. umbellifera*, *L. alpina*, *L. hudsoniana*) all exhibit variations in pigmentation throughout their geographic ranges (Redhead & Kuyper 1987).]

Note: The selection of names and typification of *Lichenomphalia* listed above bring into conformity the species epithets adopted for *Omphalina* by M. Lange in **Nordic Macromycetes Vol. 2** (Hansen & Knudsen 1992) and by Senn-Irlet et al. (1990). We hesitate to transfer to *Lichenomphalia* the sterile lichen, *Omphalina foliacea* Jørgensen (1989), which remarkably was described as an *Omphalina* despite the lack of known basidiomata (or ascomata), or any proof, other than suspicion, that it represents a Basidiomycete.

***Arrhenia* Fries, Summa Veget. p. 312. 1849.**

= *Boehmia* Raddi 1807 nom. rej. (Greuter et al. 2000)

= *Corniola* Gray 1821 non *Corniola* Adans. 1763
= *Leptotus* P. Karst. 1879
= *Leptoglossum* P. Karst. 1879
= *Dictyolus* Quél. 1886
= *Geotus* Pilát & Svrček 1953
= *Phaeotellus* Kühner & Lamoure 1972
= *Arrhenia* subg. *Phaeotellus* (Kühner & Lamoure) Kühner 1980
= *Clitocybe* subg. *Atroviridae* Bigelow 1982
= *Omphalina* sect. *Atroviridae* (Bigelow) Redhead 1986
= *Leptoglossum* subg. *Phaeotellus* (Kühner & Lamoure) Singer 1986

**Previously transferred and accepted species of cyphelloid, nutant, or cantharelloid taxa:**

*A. acerosa* (Fr.) Kühner (1980: 893 & 992) (type for *Phaeotellus* Kühner & Lamoure 1972)
 ?= *A. latispora* (Favre) Bon & Courtecuisse (1987: 37)
*A. alnetorum* (Singer) Redhead (1984: 875) Note: correction of epithet, genitive plural of *alnetum*, i.e. alder wood), supplied by J.A. Nannfeldt (pers. comm. 1984).
*A. auriscalpium* (Fr.) Fr. (1849: ) (lectotype for *Arrhenia* Fr. 1849)
*A. australis* (Clel.) Grgurinovic (1997: 318)
*A. fissa* (Leys.) Redhead (1984: 875)
*A. griseopallida* (Desm.) Watling (1988: 553)
*A. lobata* (Pers.: Fr.) Kühner & Lamoure ex Redhead (1984: 871) (lectotype for *Dictyolus* Quél. 1886)
*A. retiruga* (Bull.: Fr.) Redhead (1984: 873) (lectotype for *Leptotus* P. Karst. 1879)
*A. rickenii* (Hora) Watling (1988: 553)
*A. salina* (Høiland) Bon & Courtecuisse (1987: 37) [superfl. comb. by Gulden 1988]
*A. spathulata* (Fr.) Redhead (1984: 876) (= *Cantharellus muscigenus* (Bull.: Fr.) Fr. lectotype for *Leptoglossum* P. Karst. 1879: non *Arrhenia muscigena* (Pers.: Fr.) Quél. 1888 = *Cyphellostereum laeve* (Fr.) Reid, see Redhead 1984: 876)

## Required new combinations:

***Arrhenia andina* (Corner) comb. nov.**, Basionym: *Leptoglossum andinum* Corner, Monogr. Cantharelloid Fungi, p. 140. 1966.

***Arrhenia antarctica* (Singer) comb. nov.** Basionym: *Omphalina antarctica* Singer, Beih. Sydowia 1: 16. 1956.

***Arrhenia baeospora* (Singer) comb. nov.**, Basionym: *Omphalina baeospora* Singer, Z. Pilzk. 43: 120. 1977.

***Arrhenia chilensis* (Mont.) comb. nov.** Basionym: *Agaricus chilensis* Mont., Ann. Sc. Nat. II, 8: 368. 1837.

***Arrhenia chlorocyanea* (Pat.) comb. nov.** Basionym: *Agaricus chlorocyaneus* Pat., Tab. anal. Fung. 4: 145. 1885.

Comments: The taxonomic concept adopted here is that of Redhead (1986) under the name *Omphalina viridis* (Hornem.) Kuyper (= *Agaricus ericetorum* var. *viridis* Hornem., incorrectly listed as "*Agaricus umbelliferus* var. *viridis* Hornem." by Kuyper 1995 as a synonym of *Omphalina chlorocyanea* (Pat.) Singer). *Clitocybe atroviridis* Bigelow (1982) was treated as a synonym by both Redhead (1986) and Kuyper (1995). Bigelow (1985: 413-414), defended publication of his new species, but agreed that European collections that he had earlier reported to lack clamp connections (Bigelow 1982), in fact had clamp connections. He then noted that a North American collection (A.H. Smith 70705, MICH) representing "*Omphalina umbellifera* var. *viridis*" lacked clamp connections. However, that collection was later examined by SAR and redetermined as *Chrysomphalina grossula* (Pers.) Norvell et al., a clampless, much paler species lacking bluish green coloration (Norvell et al. 1994). Nonetheless, Bigelow's (1982) name, *Clitocybe atroviridis*, is the only uncontroversial name linked to the vernal species represented by extant specimens because of the availability of Bigelow's type specimen. Having established that reports of a clampless species similar to the currently recognized one were either false or based upon a wholly different species and genus, there remains only the presence of hairs on the stipes, as depicted by Patouillard (1885) as a barrier to acceptance of Patouillard's earlier name. Specimens identified as A. chlorocyaneus that might have served as type, are absent from Patouillard's herbarium in the Farlow herbarium, as confirmed by the late H.E. Bigelow (pers. comm. to SAR), and by L.L. Norvell & D. Pfister more recently (pers. com. to SAR). Almost all collections, of the bluish green omphalinoid taxon cited by Redhead (1986) and Bigelow (1982) have glabrous stipes, but on some there are projecting hyphal ends, sometimes drawn into wisps (e.g., DAOM 188208). Environmental conditions, if not genetic variability, may well explain the occasional occurrence of minutely pubescent stipes. In the absence of the discovery of another vernal bluish green species in France, and the predominantly spring fruitings of the species as we know it in both Europe and North America, we adopt here the epithet published by Patouillard.

***Arrhenia epichysium* (Pers.: Fr.) comb. nov.** Basionym: *Agaricus epichysium* Pers. Syn. Meth. Fung. p. 462. 1801. [*Agaricus epichysium* Pers.: Fr., Syst. Mycol. 1: 169. 1821.]

***Arrhenia elegans* (Pers.) comb. nov**. Basionym: *Merulius elegans* Pers., Syn. Meth. Fung. p. 481. 1801.

***Arrhenia hohensis* (A.H. Smith) comb. nov.** Basionym: *Omphalia hohensis* A.H. Smith, Contr. Univ. Mich. Herb. 5: 27. 1941.

***Arrhenia lundellii* (Pilát) comb. nov.**, Basionym: *Omphalia lundellii* Pilát, Friesii 5: 26-28. 1954.

***Arrhenia obatra* (Favre) comb. nov.** Basionym: *Omphalia obatra* Favre, Les Champignons supérieurs de la zone alpine du Parc National Suisse. Résultats des recherches scientifiques entreprises au Parc National suisse. 5 (N.S.): 46, 199. 1955 [see Lamoure 1975].

***Arrhenia obscurata* (D. Reid) comb. nov.**, Basionym: *Omphalina obscurata* D. Reid, Trans. Brit. Mycol. Soc. 41: 419. 1958. [Note: = *Clitocybe atrobrunnea* Bigelow 1985, nom. nov.].

***Arrhenia omnivora* (Agerer) comb. nov.** Basionym: *Leptoglossum omnivorum* Agerer, Trans. Brit. Mycol. Soc. 82: 184. 1984. [Holotype at K examined by SAR; the assumption is made here that the subtle membranal pigments are indications of affinities with other *Arrhenia* species, rather than with *Rimbachia*].

***Arrhenia onisca* (Fr.: Fr.) comb. nov.** Basionym: *Agaricus oniscus Fr., Obs. Mycol. 2: 209. 1818. [Agaricus oniscus* Fr.: Fr., Syst. mycol. 1: 172. 1821].

***Arrhenia parvivelutina* (Clémençon & Irlet) comb. nov.**, Basionym: *Omphalina parvivelutina* Clémençon & Irlet, Schw. Z. Pilzk. 1982A Sondernummer 123 (Mycologia Helvetica): 15. 1982.

***Arrhenia pauxilla* (Clémençon) comb. nov.**, Basionym: *Omphalina* *pauxilla* Clémençon, Z. Mykol. 48: 213. 1982.

***Arrhenia peltigerina* (Peck) comb. nov.** Basionym: *Agaricus peltigerinus* Peck, Rep. New York State Mus. (for 1876) 30: 38. 1878.

***Arrhenia philonotis* (Lasch) comb. nov.** Basionym: *Agaricus philonotis* Lasch, Linnaea 3: 394. 1828.

***Arrhenia pubescentipes* (Bigelow) comb. nov.** Basionym: *Clitocybe pubescentipes* Bigelow, Beih. Nova Hedw. 81: 389. 1985.

***Arrhenia rainierensis* (Bigelow) comb. nov.** Basionym: *Clitocybe rainierensis* Bigelow, Beih. Nova Hedw. 81: 390. 1985.

***Arrhenia rigidipes* (Lamoure) comb. nov.** Basionym: *Omphalina rigidipes* Lamoure, Arctic & Alpine Mycol. (First Intl. Symp. Arcto-Alpine Mycology) p. 207. 1982.

***Arrhenia rustica* (Fr.) comb. nov.** Basionym: *Agaricus rusticus* Fr., Epicr. Syst. Mycol. p. 126, 1838. Note: see Jørgensen & Ryman 1989b: 141 for typification.

***Arrhenia sphaerospora* (Lamoure) comb. nov.** Basionym: *Omphalina sphaerospora* Lamoure, Trav. Sci. Parc Natl. Vanoise 6: 164. 1975.

***Arrhenia sphagnicola* (Berk.) comb. nov.** Basionym: *Agaricus sphagnicola* Berk., British Fungi, English Flora 5(2): 67. 1836. (Note: see Redhead & Kuyper 1987 for comments on types).

***Arrhenia stercoraria* (Barrasa, Esteve-Rav. & Sánchez) comb. nov.** Basionym: *Glabrocyphella stercoraria* Barrasa, Esteve-Rav. & Sánchez Mycol. Res. 102: 1265. 1998.

***Arrhenia subglobispora* (Moreno, Heykoop & Horak) comb. nov.** Basionym: *Omphalina subglobispora* Moreno, Heykoop & Horak, Mycotaxon 77: 366. 2001.

***Arrhenia subobscura* (Singer) comb. nov.** Basionym: *Omphalina subobscura* Singer, Flora Neotropica 3: 21. 1970.

***Arrhenia subumbratilis* (Singer) comb. nov.** Basionym: *Omphalina subumbratilis* Singer, Flora Neotropica 3: 23. 1970.

***Arrhenia trigonospora* (Lamoure) comb. nov.** Basionym: *Omphalina trigonospora* Lamoure, Trav. Sci. Parc Natl. Vanoise 6: 157. 1975.

***Arrhenia umbratilis* (Fr.: Fr.) comb. nov**. Basionym: *Agaricus umbratilis* Fr.:Fr. Syst. Mycol. 1: 157. 1821.

***Arrhenia velutipes* (P.D. Orton) comb. nov.** Basionym: *Omphalina* *velutipes* P.D. Orton, Trans. Brit. Mycol. Soc. 43: 337. 1960.

***Arrhenia viridimammata* (Pilát) comb. nov.** Basionym: *Omphalia viridimammata* Pilát, Friesii 5: 25-26. 1954.

***Arrhenia volkertii* (Murr.) comb. nov.** Basionym: *Omphalia volkertii* Murrill, Mycologia 3: 98. 1911. [see Bigelow 1985 for type study].

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# PLUTEUS SECTION PLUTEUS (PLUTEACEAE, AGARICALES) FROM KERALA STATE, INDIA

C.K. PRADEEP, K.B. VRINDA AND T.K. ABRAHAM

Tropical Botanic Garden and Research Institute, Palode,
Thiruvananthapuram-695 562, Kerala, India
E-mail <ckp123@rediffmail.com>

## Abstract

The genus *Pluteus* section *Pluteus* is represented in Kerala by four species. Among these *P. martinicensis* and *P. amphicystsis* are rare and remarkable, the former known only from the type locality while the latter besides from the type was also reported from Martinique. These taxa are described, illustrated and discussed in conjunction with *P. subcervinus* whereas only collection data is provided for *P. cervinus*.

**Key words**: Rare, Noteworthy, *Pluteus*, India.

The earliest record of *Pluteus* Fr. from India was that of Berkeley (as *Agaricus*, 1850, 1852) from the northeastern States. It was followed by several sporadic reports by various workers in India (Horak, 1980; Watling & Gregory, 1980; Natarajan & Raman, 1980;Natarajan & Purushothama, 1987; Abraham, 1994). However no species of *Pluteus* was recorded from Kerala prior to this study.

While studying the agaric flora of Kerala State, we had the opportunity to collect and study four species of *Pluteus* belonging to the section *Pluteus*. Of these, *P. cervinus* (Schaeff.) Kumm. was earlier recorded from Jammu & Kashmir (Watling & Gregory, 1980) and Tamil Nadu (Natarajan & Raman, 1980).

Collections were made and studied using conventional mycological techniques (Largent *et al.*, 1977; Singer, 1986). Descriptions are based on fresh collections made by the authors. All microstructures were studied in 3% KOH solution. Colour terms and notations are those of Kornerup and Wanscher (1967). Spore sizes were based on measurements of 30 spores. All collections examined are deposited in the herbarium of the Royal Botanic Gardens, Kew (K).

## Key to the species of *Pluteus* section *Pluteus* in Kerala

1. Metuloids simple, lacking apical prongs;pileus yellowis hwhite.......*P. amphicystis*
1. Metuloids with 2-6 apical prongs; pileus some shade of brown..........................2
2. Lamella edge brown; caulocystidia present....................................*P. martinicensis*
2. Lamella edge concolorous; caulocystidia absent...............................................3
3. Clamp-connections present; pileus dry, scrobiculate........................*P.subcervinus*
3. Clamp-connections absent; pileus viscid, smooth................................*P. cervinus*

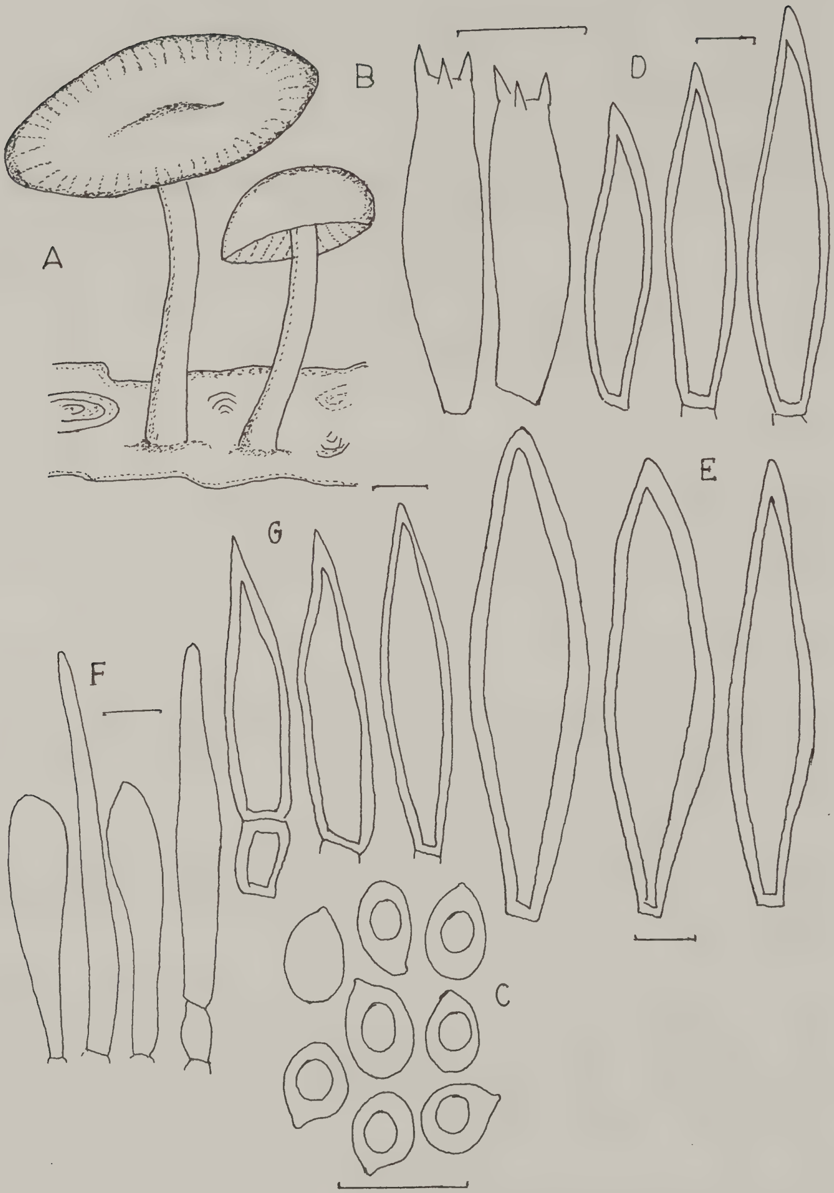

Fig.1. *Pluteus amphicystis*. A. habit x 1; B. basidia; C. spores; D cheilocystidia; E. pleurocystidia; F. Pileocystidia; G. caulocystidia. Scale bar=10µm

***Pluteus amphicystis*** Singer, *Lloydia* 21:213. 1958. Fig.1. A-G

Pileus 3.5-7 cm diam., convex to applanate, broadly umbonate or with an inconspicuous umbo; surface 'yellowish white' (3A2), 'greyish orange' (5B3) to white towards margin, fibrillose to squamulose especially at the centre, moist, pellucid-striate; margin straight, entire. Lamellae free, white turning 'orange white' (5A2) to pink, up to 10 mm wide, crowded with lamellulae of two lengths; edge concolorous to sides, entire. Stipe 3-4.5 cm x 4-5 mm, central, cylindric, equal with a dilated base, solid; surface white, 'amber yellow' (4B6) to greyish towards base, pruinate. Context white, thick, fleshy, up to 3 mm thick at the disc. Odour none. Spore print 'persian orange' (6A7).

Spores 5.25-6 (6.75) x (3.75) 4.5-5.25 µm, Qm= 1.20, subglobose to slightly ellipsoid, thick-walled, monoguttulate. Basidia 19.5-24 x 5.25-6.75 µm, clavate, 4-spored. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 27-79.5 x 7.5-21 µm, ventricose-fusoid, metuloidal, thick-walled, mucronate, hyaline. Pleurocystidia abundant, 60-81 x 13.5-22.5 µm, metuloidal, simple, with out apical horns, hyaline. Hymenophoral trama inversely bilateral with convergent hyphae, 1.5-18 µm diam., thin-walled, hyaline. Subhymenium pseudoparenchymatous. Pileal trama consists of interwoven hyphae, 2-20 µm diam., thin-walled, hyaline. Pileipellis a trichoderm consisting of two types of elements; a uniform layer of cylindroclavate elements, 19.5 -75 x 7.5-10.5 µm, thin-walled, intermingled with long cystidioid elements, 57-105 x 6.75-10.5 µm, lanceolate, fusoid ventricose, thin-walled. Both elements contain pale greyish intracellular pigment. Pileal hyphae 2.25-10.5 µm diam., thin-walled, without clamp-connections. Stipe trama composed of inflated parallel hyphae 3-16.5 µm diam., thin-walled, hyaline. Caulocystidia abundant, more in the upper part, in-groups, 22.5-52.5 x 9-12 µm, lanceolate, similar to cheilocystidia, thick-walled, metuloidal with pale brown contents; rarely clavate, thin-walled elements are also observed. Oleiferous hyphae present. Clamp-connections lacking.

Solitary or in pairs on dead, decaying angiosperm trees or on logs.

**Specimens examined**: India, Kerala State, TBGRI campus: 27 Aug.1994 C.K. Pradeep K (M) 90737; ibid., 19 July 1996 C.K. Pradeep K (M) 90738.

This rare, remarkable species originally described from Bolivia (Singer, 1958) was also known from Martinique (Pegler, 1983). The present collection agrees well with the above collections. However the pileipellis structure shows little deviation. According to Singer (1958) and Pegler (1983), the pileipellis is described as an epicutis of elongated hyphae with dermatocystidioid elements. But our observations based on fresh basidiomes revealed that the pileipellis is a trichodermium. Singer (1958) described the cheilocystidia as thin-walled and non metuloidal, while Pegler (1983) described it as metuloidal and thick-walled as in the present collection.

In most of the macro and microscopic features the present collection is very close to *P. conizatus* (Berk. & Br.) Sacc. described from Sri Lanka (Pegler, 1986). However, the latter species deviates strongly in the pileipellis structure and in the absence of metuloidal caulocystidia.

The yellowish pigmentation of the cap, simple, magnus type (Banerjee & Sundberg, 1993) metuloidal hymenial cystidia and absence of clamp-connections are the diagnostic features of this species.

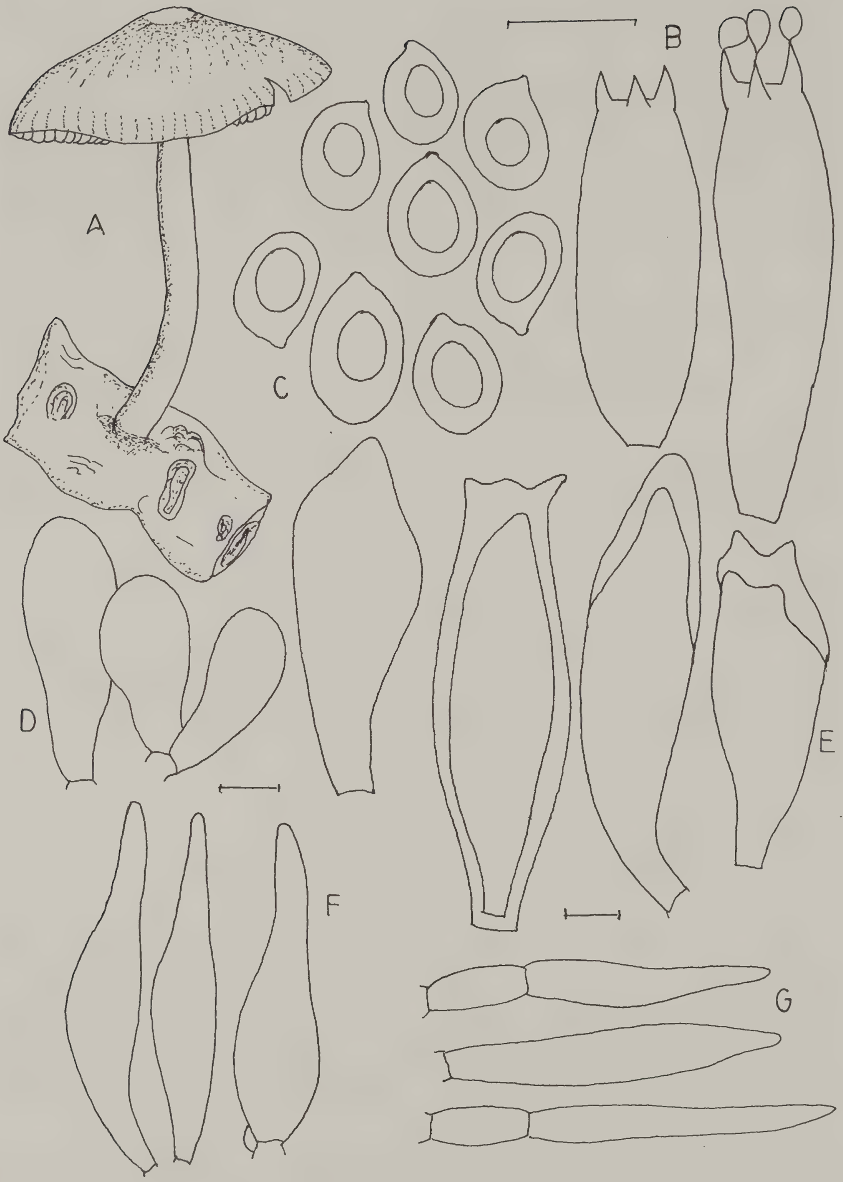

Fig.2. *Pluteus martinicensis*. A. habit x1/2; B. basidia; C. spores; D. cheilocystidia; E. pleurocystidia; F.caulocystidia ;G.Pileal elements. Scale bar=10μm

***Pluteus martinicensis*** Singer & Fiard, in Pegler, *Kew Bull. Add. Ser.* 9:311. 1983. Fig. 2. A-G

Pileus 5-9.5 cm diam., convex with a broad umbo; surface 'soot brown' (5F5) to 'brownish orange' (6C3) with 'bronze brown' (5E5) disc, fibrillose striate, moist; margin straight, entire, pellucid striate. Lamellae free, 'orange white' (6A2) to 'pinkish white' (7A2), up to 9 mm broad, crowded with lamellulae of different lengths; edge concolourous with the sides or brown, entire. Stipe 5.5-12.5 cm x 6-10 mm, central, cylindric, equal or narrowly tapering from a slightly broad base; surface 'nougat' (5D3) to 'brownish beige' (6E3), dull white towards the apex, fibrillose squamulose. Context off-white to 'dust' (5D2), up to 5 mm thick at the disc, soft. Odour none.

Spores 6-7.5 (9) x 6-6.75 (7.5) µm, Qm=1.22, subglobose to broadly ellipsoid, thick-walled with a guttule. Basidia 22.5-31.5 x 9-12 µm, clavate, 4-spored. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 27-75 x 13.5-22.5 µm, clavate, cylindroclavate, hyaline or with pale brown contents, thin-walled. Pleurocystidia scattered, abundant, 45-81 x 15-22.5 µm, thick-walled, metuloidal, fusoid ventricose to lageniform with 2-4 apical prongs or with obtuse apex, thick-walled, hyaline. Hymenophoral trama inversely bilateral with convergent hyphae, 3-21 µm diam., thin-walled, hyaline. Subhymenium pseudoparenchymatous. Pileal trama of interwoven hyphae, 6-22 µm diam., inflated, thin-walled, hyaline. Pileipellis a repent epicutis composed of parallel hyphae, 4.5-22.5 µm diam., thin-walled with brown contents, often with suberect terminal elements, 66-94.5 x 11.5-13 µm, thin-walled, with acute apices. Stipe trama of parallel hyphae, 3-22.5 µm diam., thin-walled. Caulocystidia present over the entire stipe surface. Caulocystidia 45-82.5 x 9-13.5 µm, versiform, fusoid to lageniform, often mucronate, thin-walled with brown contents. Oleiferous hyphae present in pileus trama. Clamp-connections present in pileipellis and stipitipellis hyphae.

Solitary on Bamboo debris and on partially decayed angiosperm wood.

**Specimens examined**: India, Kerala State, TBGRI campus: 4 April 1995 C.K.Pradeep K (M) 90739; 13 June 1996, C.K.Pradeep K (M) 90740.

This rare, noteworthy species was originally described and hitherto known only from Martinique (Pegler, 1983). The diagnostic features of this species are robust brown basidiomes, fibrillose-striate pileus, coloured lamella-edge, presence of tufts of caulocystidia over the entire stipe surface and clamp-connections in pileipellis and stiptipellis hyphae. Our collection while showing remarkable resemblance to the Martinique material (Pegler, 1983) deviates in its slightly larger basidiome, larger cheilocystidia and larger spores.

Various workers have considered the coloured lamella-edge as a reliable taxonomic character at least in the genus *Pluteus* (Singer, 1956, 1958; Smith & Stuntz, 1958; Banerjee & Sundberg, 1995). However, Pegler (1983) cautioned the use of coloured lamella edge as a reliable taxonomic character as it is not constant within a species. Out of the two collections made from Kerala, only one has coloured lamella-edge.

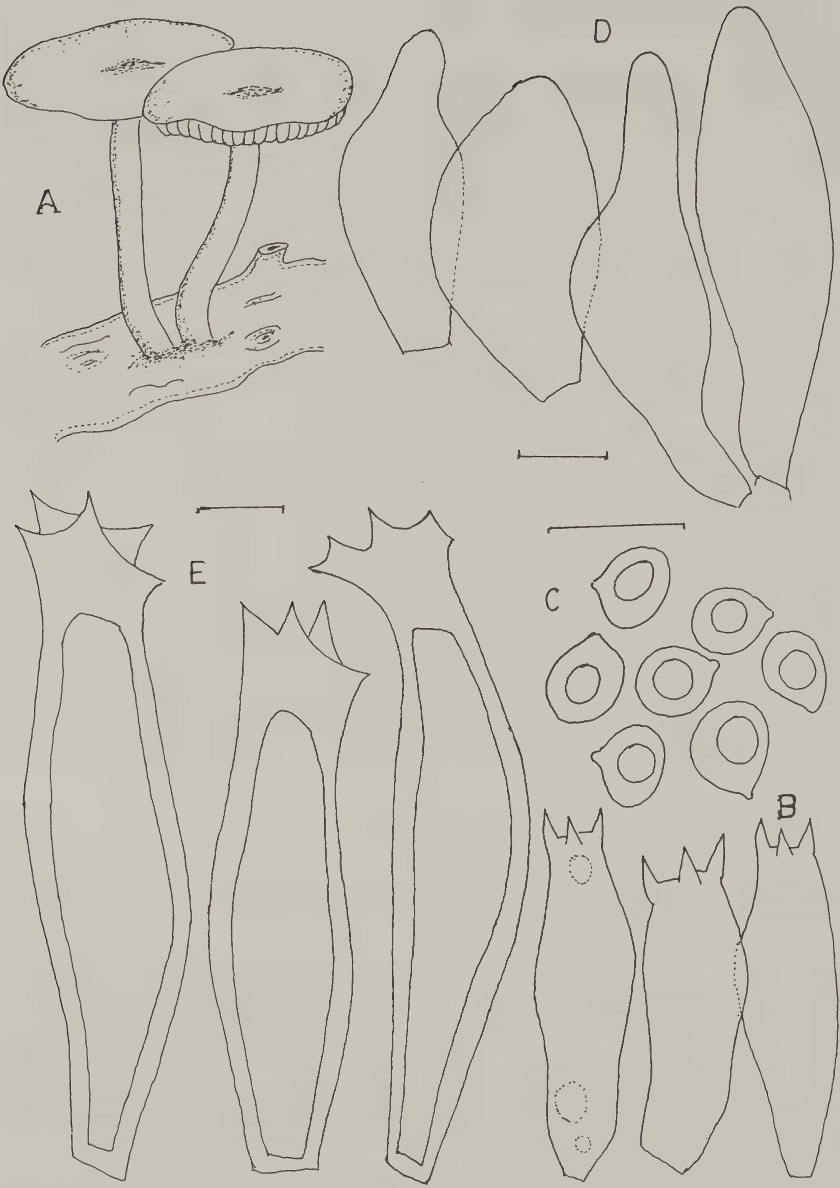

Fig. 3. *Pluteus subcervinus*. A. habit x1/2; B. basidia; C. spores; D. cheilocystidia; E. pleurocystidia. Scale bar=10µm

**Pluteus subcervinus** (Berk. & Br.) Sacc., Syll. Fung.5:666. Fig.3. A-E

Pileus 5.5-8 cm diam., subumbonate, applanate or shallowly depressed at the disc; surface 'camel' (6D4), 'dark brown' (6F7) at the disc, scrobiculate or wrinkled at the disc, smooth elsewhere, dry; margin straight, pellucid-striate, entire. Lamellae free, 'flesh' (6B3), up to 10 mm wide, crowded with lamellulae of different lengths; edge concolourous with the sides, entire. Stipe 5.5-7 cm x 4-6 mm, central, cylindric, equal with a broad base, solid; surface white, glabrous. Context pink, up to 3 mm thick at the disc, soft. Odour none.

Spores 5.25-6.75(7.5) x 4.5-5.25(6) µm, Qm=1.29, subglobose to ellipsoid, thick-walled, monoguttulate. Basidia 19.5-25.5 x 6.75-8.25 µm, clavate, 4-spored. Lamella edge sterile with crowded cheilocystidia. Cheilocystidia 24-49.5 x 10.5-18 µm, narrowly clavate to clavate, often with a short neck or capitulum, thin-walled, hyaline. Pleurocystidia abundant, 64.5-82.5 x 12-16.5 µm, thick-walled, metuloidal, fusoid ventricose with 2-6 acute apical horns, often with mucilaginous covering to which masses of spores adhere. Hymenophoral trama inversely bilateral with convergent hyphae, 3-22.5 µm diam., inflated, thin-walled, hyaline. Subhymenium pseudoparenchymatous. Pileal trama of interwoven hyphae, 3-37.5 µm diam., inflated, thin-walled, hyaline. Pileipellis an epicutis of radially parallel hyphae, 3-10.5 µm diam., inflated to 27 µm diam., thin-walled with obtuse apices, containing brown intracellular pigment. Stipe trama composed of parallel hyphae, hyphae similar to pileipellis hyphae, thin-walled, hyaline. Caulocystidia absent. Oleiferous hyphae present in pileal and stipe trama. Clamp-connections present in pileipellis hyphae.

In groups on rotting angiosperm wood in evergreen forest.

**Specimens examined**: India, Kerala State, Silent Valley National Park, Palakkad: 16 May 1994, C.K.Pradeep K (M) 90736.

Except for the slightly large basidiomes of the present collection it matches well with *P.subcervinus* (Pegler, 1986) This species shows affinity with a number of taxa viz., *P. brunneidiscus* Murr., *P. cervinus* (Schaeff.)Kumm., *P. washingtonensis* Murr. and *P.salicinus* (Pers.) Kumm. complex. However, camel brown pileus with dark brown disc, smooth pileus, white glabrous stipe and pileipellis hyphae with clamp-connections can distinguish this taxon.

**Pluteus cervinus** (Schaeff.) P. Kumm. Fuhr. Pilzk.:99. 1871.

Solitary on dead Acacia log in Acacia plantation.

**Specimen examined**: India, Kerala State, Munnar, Idukki: 27 July 1999, C.K. Pradeep K (M) 90735.

The diagnostic features of this common widely known species is the umbonate brown viscid pileus, white glabrous stipe, cervinus type metuloids and clampless pileipellis hyphae. The Kerala material matches macro and microscopically with that of Banerjee and Sundberg (1995) except for the slightly smaller spores (5.25-7.5 x 4.5-5.25 µm) of the present collection.

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# REVISION OF AMANITA COLLECTIONS FROM JILIN PROVINCE, NORTHEASTERN CHINA*

ZHU L. YANG

Kunming Institute of Botany, Academia Sinica, Kunming 650204, China
E-mail address: zlyang@public.km.yn.cn

**Abstract:** A critical re-examination of collections of *Amanita* (Basidiomycetes) collected from Jilin (Kirin) Province, northeastern China, indicated that many of them were wrongly identified, and corrections should be made. Ten taxa are reported in this account. A detailed description with an illustration is provided for *A. subjunquillea.*

**Key words:** Agaricales, Basidiomycetes, distribution, Kirin, taxonomy

## Introduction

Amanitas in Jilin (Kirin) Province, northeastern China, have received much attention in the last century. Up to now, about twenty taxa of the genus *Amanita* Pers. have been reported from the province (Teng, 1963; Tai 1979; Kobayasi, 1982; Xie *et al*., 1986; Li, 1991; Teng, 1996; Shao & Xiang, 1997; and many others). Collections of *Amanita* made from Jilin Province were re-examined. Unfortunately, critical re-examinations indicate that many vouchers were wrongly identified, and the misidentifications should be corrected. The new findings are published here. The collections are deposited in the Herbarium of the Institute of Microbiology, the Chinese Academy of Sciences (HMAS) and the Herbarium of Shengyang Institute of Applied Ecology, the Chinese Academy of Sciences (IFP). *Amanita subjunquillea* S. Imai is described in detailed. For the other taxa treated, detailed descriptions can be found in other publications, therefore, only vital information on those taxa will be provided here. Methods and terminology follow those of Yang (1997) and Yang *et al.* (2001).

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## Taxonomy

**1. *Amanita flavipes*** S. Imai, Bot. Mag. (Tokyo) 47: 428 (1933)

Pileus 3.5–5 cm in diam., convex to applanate, center brown, becoming yellowish to brownish towards the margin, covered with dirty white to yellowish, verrucose to felty volval remnants (2–5 × 2–3 mm large, and 0.5–1 mm thick), sometimes glabrous (volval remnants probably washed away by rain?). Stipe 6–8 × 0.5–1 cm, subcylindric; basal bulb subglobose, ca. 1 cm in diam., immarginate, upper part covered with small, irregularly arranged, yellowish volval remnants. Annulus persistent, pendant from attachment 1–2.5 cm below apex of stipe, yellow to yellowish.

Basidia 4-spored; basal septa without clamps. Basidiospores [40/2/2] 6.5–8.5(9.0) × (5.0)5.5–7.0 µm [Q = (1.14)1.20–1.42(1.50), **Q** = 1.28 ± 0.08], broadly ellipsoid to ellipsoid, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small.

**Material examined:** JILIN PROV: Antu County, Mt. Changbai, Y. Wang 811325, 811038 (IFP).

**Observations:** Wang 811325, and 811038 were regarded as *A.citrina*, and *A. porphyria* by Xie *et al.* (1986) respectively. However, *A. citrna* (Schaeff.) Pers., originally described from Europe, has a truncate to subtruncate bulb on the stipe base, raw potato smell, and larger, rounder basidiospores (Breitenbach & Kränzlin, 1995; unpublished data of Yang studying material from Germany-HKAS 31449 and 31537). *Amanita porphyria* (Alb. & Schwein.: Fr.) Alb. & Schwein., originally also described from Europe, has a grey-brown to reddish brown pileus with greyish to violet-grey volval remnants, greyish to purplish annulus, and globose to subglobose spores (Phillips, 1990; Breitenbach & Kränzlin, 1995; Chen *et al.*, 2001). For detailed descriptions of *A. flavipes* see Yang (1997) and Tulloss *et al.* (2001).

**2. *Amanita fritillaria*** (Berk.) Sacc., Syll. Fung. 9: 2 (1891)

Pileus ca. 7 cm in diam., convex, blackish brown at disc, becoming brown to brownish towards the margin, covered with grey brown, felty volval remnants. Stipe 10 × 1 cm, subcylindric; basal bulb ovoid, ca. 1.5 cm in diam., upper part covered with indistinct, greyish volval remnants often in belts. Annulus persistent, superior, upper surface white, lower surface whitish to greyish.

Basidia 4-spored; basal septa without clamps. Basidiospores [20/1/1] 7.0–8.5 × (5.5)6.0–6.5 µm [Q = 1.16–1.30(1.34), **Q** = 1.24 ± 0.06], broadly ellipsoid, rarely ellipsoid, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small.

**Material examined:** JILIN PROV: Fusong County, Mt. Changbai, Z. X. Xie 820755 (IFP).

**Observations:** Xie 820755 was regarded as *A. porphyria* by Xie *et al.* (1986).

However, *A. porphyria* from Europe has, among other features, a more or less limbate volva on the stipe base, and larger, globose to subglobose basidiospores (Phillips, 1990; Breitenbach & Kränzlin, 1995; Chen *et al*., 2001). For a detailed description of *A. fritillaria* see Yang (1997).

**3.** ***Amanita hemibapha*** (Berk. & Broome) Sacc., Syll. Fung. 5:13 (1887)

Pileus 11 cm in diam., convex to almost applanate, distinctly umbonate, margin long striate (0.2–0.31R), glabrous. Stipe 18 × 1–2 cm, attenuate upwards, glabrous to subglabrous, but with fine squamules towards the base; basal bulb lacking. Volva sacate, 6 × 3.5 cm, dirty white. Annulus persistent, pendant from attachment ca. 3 cm below apex of stipe.

Basidia 4-spored; basal septa often with clamps. Basidiospores [25/1/1] 7.0–10.0 × (6.0)6.5–7.5(8.0) µm [Q = (1.13)1.20–1.36, **Q** = 1.26 ± 0.06], broadly ellipsoid to ellipsoid, rarely subglobose, inamyloid, colorless, hyaline, thin-walled, smooth; apiculus small.

**Material examined:** JILIN PROV: Antu County, Mt. Changbai, Y. Wang 811289 (IFP).

**Observations:** Wang 811289 was regarded as *A. caesarea* by Xie *et al*. (1986). However, *A. caesarea* (Scop.: Fr.) Pers., originally described from Europe, has a much fleshier, hardly striate pileus without umbo, and proportionally shorter stipe. *Amanita caesareoides* Lar. N. Vassiljeva, originally described from the far east Russia (Vassiljeva, 1950), is very close to *A. hemibapha* and *A. ceasarea*. Its taxonomical limit against the latter two is still unclear (Bas, 1977). Because the collection studied was accompanied with no field notes, thus the name *A. hemibapha* has been used in its broad sense in this paper. For a detailed key to this group see Tulloss (1998).

**4.** ***Amanita orientigemmata*** [as "*orientogemmata*"] Zhu L. Yang & Yoshim. Doi, Bull. Natn. Sci. Mus., Tokyo, Ser. B. 25 (3): 107, figs. 1–4 (1999)

Pileus ca. 4 cm in diam., brownish at disc, yellowish to cream towards the striate margin, glabrous (volval remnants washed away by rain?). Stipe 9 × 0.5–1 cm, subcylindric; basal bulb subglobose, 1.2–1.5 cm in diam.; volva short limbate, whitish to cream. Annulus not seen.

Basidia 4-spored; clamps common. Basidiospores [20/1/1] (8.5)9.0–10.5 × 7.5–8.5(9.0) µm [Q = 1.13–1.24(1.27), **Q** = 1.19 ± 0.04], broadly ellipsoid, sometimes subglobose, inamyloid, colorless, hyaline, thin-walled, smooth; apiculus small.

**Material examined:** JILIN PROV: Antu County, Mt. Changbai, Y. Wang 811333 (IFP).

**Observations:** Wang 811333 was regarded as *A. vaginata* by Xie *et al*. (1986). However, *A. vaginata* (Bull.: Fr.) Larm., originally described from Europe, has, among other features, a grey to greyish pileus, a non-bulbous stipe, a saccate volva, globose spores, and no clamps. For a detailed description of *A.*

*orientigemmata* see Yang & Doi (1999).

**5. *Amanita sepiacea*** S. Imai, Bot. Mag. (Tokyo) 47: 426 (1933)

Pileus 6–8.5 cm in diam., convex, dark brown to blackish brown at disc, becoming greyish brown to brown towards margin, covered with dirty white to brownish, subverrucose to felty volval remnants, sometimes glabrous (volval remnants washed away by rain?). Stipe 10–11 × 0.5–1.5 cm, subcylindric; basal bulb subglobose, ca. 1.5 cm in diam., upper part of bulb and lower part of stipe covered with dirty white, occasionally greyish verrucose volval remnants. Annulus persistent, pendant from attachment ca. 2 cm below apex of stipe, membranous.

Basidia 4-spored; clamps lacking. Basidiospores [40/2/2] 7.0–9.0(10.0) × (5.5)6.0–7.5 µm [Q = (1.11)1.17–1.38(1.50), **Q** = 1.29 ± 0.08], broadly ellipsoid, occasionally subglobose or ellipsoid, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small. Volval remnants on pileus and stipe base dominantly made up of inflated cells.

**Material examined:** JILIN PROV: Changbai County, Mt. Changbai, Z. X. Xie 820684 (IFP); Fusong County, Mts. Changbai, Z. X. Xie 820735 (IFP).

**Observations:** Xie 820684 and 820735 were regarded as *A. phalloides* by Xie *et al.* (1986). However, *A. phalloides* (Fr.: Fr.) Link, originally described from Europe, has, among other features, a differently colored pileus, a white to dirty white limbate volva on the stipe base dominantly made up of filamentous hyphae, and proportionally wider basidiospores (Breitenbach & Kränzlin, 1995; Yang, 1997: 174).

**6. *Amanita subglobosa*** Zhu L. Yang, Biblioth. Mycol. 170: 18, Abb. 5-9 (1997)

Pileus 4–10(14) cm in diam., convex to almost applanate, center brown, yellowish brown towards the margin, covered with whitish, dirty white to yellowish to brownish, verrucouse to subconical, sometimes felty volval remnants. Margin striate (0.11–0.22R). Stipe 7–15(24) × 0.5–2(3) cm, subcylindrical; towards the base often with reflexed squamules; bulb subglobose, ventricose to broadly clavate, ca. 1–2.5 cm in diam., upper part covered with volval remnants in (1)2–4 concentric rows or shortly limbate. Annulus persistent, pendant from attachment 2–3 cm below apex of stipe.

Basidia 4-spored, rarely 1- or 2-spored; basal septa often with clamps. Basidiospores [115/7/7] (8.0)9.0–12.0(13.0) × (6.5)7.0–9.0(9.5) µm [Q = (1.05) 1.19–1.50(1.63), **Q** = 1.34 ± 0.10], broadly ellipsoid to ellipsoid, sometimes subglobose, rarely elongate, inamyloid, colorless, hyaline, thin-walled, smooth; apiculus small.

**Material examined:** JILIN PROV: Antu County, Mt. Changbai, Y. Wang 811018, 811238 (IFP); Y. C. Yang *et al.* 515, 701, 798, 799, and 800 (HMAS 29131, 29132, 29130, 29129, and 30833 respectively).

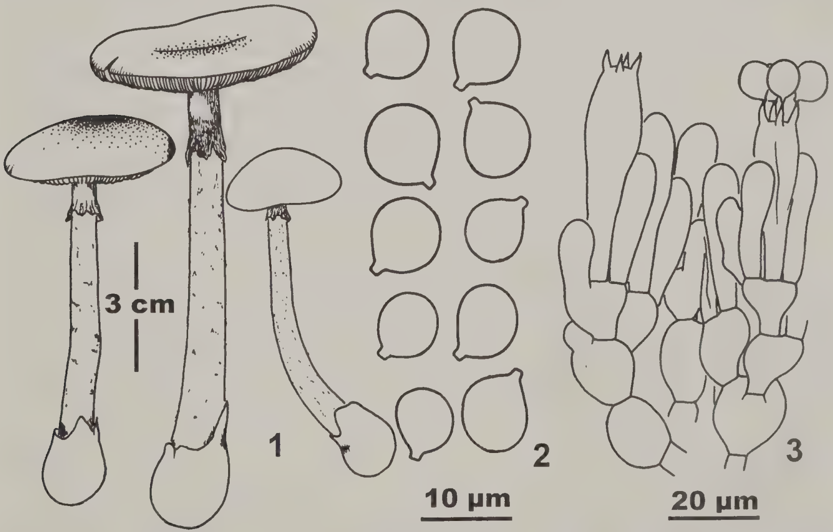
**Observations:** Wang 811018 and 811238 were regarded as *A. pantherina* by

Xie *et al.* (1986). The other collections cited above were identified as *A. pantherina* by the late Professor S. C. Teng (see Teng, 1963: 605; 1996: 450). However, *A. pantherina* (DC.: Fr.) Krombh., originally described from Europe, has white to dirty white volval remnants on the pileus, somewhat smaller spores, no clamps and a greater preponderance of cylindrical hyphae in the volval remnants on the stipe base (Breitenbach & Kränzlin, 1995; Yang, 1997: 23, 47).

**7. *Amanita subjunquillea*** S. Imai, Bot. Mag. (Tokyo) 47: 424 (1933)

Basidiocarp (fig. 1) small to medium-sized. Pileus (2)3–7 cm in diam., at first subconical, then convex to applanate, sometimes slightly depressed at center when mature, glabrous, yellowish to lemon yellow [3A4–8], somewhat darker over disc; margin non-striate, but becoming finely striate when old, non-appendiculate; trama white. Lamellae free, white to whitish [1A1–2], crowded; lamellulae attenuate, plentiful, in 2-3 ranks. Stipe 7–12 × 0.5–1 cm, subcylindric or slightly tapering upward, with apex slightly expanded, whitish to yellowish, often covered with yellowish to yellowish brown fibrillose squamules; context white. Basal bulb subglobose, 1–2 cm wide. Volva limbate, membranous, with free limb up to 1 cm in height, both surfaces white to dirty white. Annulus persistent, pendant from attachment 1–2 cm below apex of stipe, thin, membranous, upper surface white, lower surface yellowish to whitish.

Lamella trama bilateral: mediostratum 20–30 µm wide, made up of fairly abundant to abundant, long ellipsoid to subfusiform cells (50–110 × 12–25 µm), mixed with abundant frequently branching, interwoven, filamentous hyphae 2–5



Figs. 1–3: *Amanita subjunquillea* (HMAS 59783).
1. Basidiocarps; 2. Basidiospores; 3. Subhymenium and basidia.

µm wide; lateral stratum made up of fairly abundant to abundant, long ellipsoid to long clavate cells (50–90 × 12–20 µm), mixed with abundant filamentous hyphae 3–5(8) µm wide, diverging at an angle of 30°–60° to the central stratum. Subhymenium (fig. 3) 25–40 µm thick, with 2–3(4) layers of subglobose, ovoid to ellipsoid cells (10–22 × 8–16 µm), occasionally mixed with hardly inflated hyphal segments. Basidia (fig. 3) 30–48 × 9–12 µm, clavate, 4-spored, occasionally 1- or 2-spored; sterigmata 3–5 µm long; basal septa without clamps. Basidiospores (fig. 2) [220/12/9] 6.5–9.0(11.0) × (5.5)6.0–8.0 (10.0) µm [Q = (1.0)1.03–1.19(1.23), Q = 1.09 ± 0.05], globose to subglobose, occasionally broadly ellipsoid, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small. Lamella edge ± gelatinized, consisting of broadly clavate to sphaeropedunculate cells (20–30 × 10–20 µm) or ellipsoid cells (15–23 × 8–10 µm), thin-walled to slightly thick-walled, colorless, hyaline. Pileipellis 80–120 µm thick: the upper layer (30–60 µm thick) slightly to strongly gelatinized, made up of ± radially arranged, colorless, hyaline, filamentous hyphae up to 4 µm wide; the lower layer (40–60 µm thick) made up of radially and compactly arranged filamentous hyphae 3–6 µm wide, occasionally inflated to 10 µm wide, hyaline to subhyaline, sometimes with yellowish vacuolar pigment; vascular hyphae rare. Volval remnants on stipe base dominantly made up of ± irregularly and compactly arranged filamentous hyphae 3–7 µm wide, thin-walled to slightly thick-walled (up to 0.5 µm thick), colorless, hyaline, interwoven, sometimes anastomosing, clampless; inflated cells scattered, subglobose (50–120 × 40–100 µm), sometimes clavate to subfusiform (150–200 × 30–45 µm), usually single and terminal, occasionally intercalary, thin-walled, hyaline; vascular hyphae rare. Outer surface of the volva with filamentous hyphae 3–7(12) µm wide; inflated cells not seen. Inner surface of the volva gelatinized, with filamentous hyphae 2–4 µm wide. Volval remnants on pileus not seen. Stipe trama dominantly consisting of longitudinally arranged, long clavate, terminal cells (180–380 × 25–40 µm), mixed with scattered filamentous hyphae 2–5 µm wide; vascular hyphae rare, up to 15 µm wide. Annulus dominantly made up of ± subradially arranged, thin-walled, colorless, hyaline, frequently branching and interwoven, anastomosing filamentous hyphae 3–7 µm wide; mixed with scattered (on annulus lower surface) to fairly abundant (on annulus upper surface), clavate to long clavate cells (30–100 × 12–20 µm) or sometimes broadly clavate cells (25–50 × 15–20 µm), thin-walled to slightly thick-walled (up to 0.5 µm thick), colorless, hyaline, usually single and terminal; vascular hyphae rare.

**Material examined:** JILIN PROV: Antu County, Mt. Changbai, Y. Wang 811125 (IFP).

**Extralimital Material examined:** GUIZHOU PROV: Daozhen County, J. Z. Ying *et al.* 401, 405 and 475 (HMAS 59785, 59783 and 60316 respectively). HUBEI PROV: Shennongjia County, S. X. Sun 177, 216, 218 and 347 (HMAS 70166, 70169, 60186 and 70144 respectively); same location, X. Q Zhang & S.

X. Sun 350 (HMAS 57681).

**Observations:** Wang 811125, and Zhang & Sun 350 were regarded as *A. phalloides* by Xie *et al.* (1986), and Mao *et al.* separately (1989). However, *A. phalloides* from Europe has more robust basidiocarps, more inflated cells in the annulus, and larger basidiospores with higher Q (Yang, 1997: 174; unpublished data of Yang studying material from Germany-HKAS 31457 and 31625). In addition, the walls of many filamentous hyphae and inflated cells in *A. phalloides* are thicker than those in *A. subjunquillea* (Tulloss, unpublished data; Yang, unpublished data). *Amanita subjunquillea* is a deadly poisonous mushroom (Kawase *et al*., 1992).

**8. *Amanita subjunquillea*** var. ***alba*** Zhu L. Yang, Biblioth. Mycol. 170: 174, Abb. 143–144 (1997)

Pileus 3.5–5 cm in diam., convex, white to whitish. Stipe 6–10 × 0.5–1.5 cm, slightly attenuate up wards; base bulbous, 1–2 cm in diam. Volva limbate, white to dirty white, membraneous.

Basidia 4-spored; basal septa without clamps. Basidiospores [40/2/2] 7.0–9.0(9.5) × (6.5)7.0–8.0(9.0) µm [Q = 1.0–1.14(1.19), **Q** = 1.08 ± 0.05], globose to subglobose, rarely broadly ellipsoid, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small.

**Material examined:** JILIN PROV: Antu County, Mt. Changbai, Y. Wang 79340 (IFP); Mts. Changbai, Z. X. Xie 820568 (IFP).

**Observations:** Wang 79340 and Xie 820568 were regarded as *A. verna* and *A. virosa* by Xie *et al.* (1986) separately. However, *A. verna* (Bull.: Fr.) Lam., originally described from Europe, has, among other features, significantly larger, ellipsoid spores (Yang, 1997: 181; Yang & Doi, 1999: 122). *Amanita virosa* (Fr.) Bertillon from Europe has an irregularly formed, conical to campanulate pileus, a thin and fragile annulus, and distinctly larger basidiospores (Yang, 1997: 177). *Amanita subjunquillea* var. *alba* may be a lethal mushroom (Yang & Li, 2001).

**9. *Amanita* cf. *ceciliae*** (Berk. Broome) Bas, Persoonia 12: 192 (1984)

Pileus 6–10.5 cm in diam., convex to applanate, sometimes slightly umbonate, blackish brown over disc, brownish towards pileal margin, covered with dark grey, verrucose to felty volval remnants, sometimes glabrous (washed away by rain?); margin striate (0.13–0.33R). Lamellae greyish. Stipe 12–18 × 0.5–1.5 cm, attenuate upwards, surface covered with dark grey squamules; base covered with dark greyish volval remnants in 2–3 belts; basal bulb absent. Annulus absent.

Basidia 4-spored; basal septa without clamps. Basidiospores [35/3/2] (9.5)10.0–12.0(13.0) × 9.0–12.0(12.5) µm [Q = 1.0–1.11, **Q** = 1.06 ± 0.04], globose to subglobose, rarely broadly ellipsoid, inamyloid, colorless, hyaline, thin-walled, smooth; apiculus small.

**Material examined:** JILIN PROV: Antu County, Mt. Changbai, Z. X. Xie 820373 (IFP); Mts. Changbai, Y. C. Yang *et al.* 564 (HMAS 29135).

**Observations:** Xie 820373 was regarded as "*A. inaurata* Secr." by Xie *et al.* (1986). Yang *et al.* 564 was identified as *Amanitopsis strangulata* (Fr.) Roze by Teng (see Teng, 1963: 606; 1996: 451). According to Bas (1984), the correct name of "*A. inaurata* Secr." is *A. ceciliae* (Berk. & Broome) Bas, and *Amanitopsis strangulata* (Fr.) Roze (≡*Agaricus strangulatus* Fr.) is an unknown species. The collections cited above can't be regarded as *A. ceciliae*, because the true *A. ceciliae*, originally described from Europe, has a more robust fruitbody with yellow to yellow brown pileus (Corner & Bas, 1962; Phillips, 1990; Breitenbach & Kränzlin, 1995). The Chinese collections may represent a still undescribed species with slender fruitbodies. The taxonomy of this species can only be discussed in detail when well dried collections with detailed field notes are available.

**10. *Amanita* cf. *fulva*** (Schaeff.) Fr., Observ. Mycol. 1: 2 (1815)

Pileus 4–7 cm in diam., convex to applanate, umbonate, brown to dark brown over disc, becoming brown to brownish towards pileal margin, glabrous; margin striate (0.27–0.47R). Stipe 10–11 × 0.5–1 cm, subcylindric; basal bulb absent. Volva saccate, 1–2 × 1 cm, membranous, white to whitish, sometimes with brownish spots. Annulus absent.

Basidia 4-spored; basal septa without clamps. Basidiospores [40/2/2] (8.5)9.5–12.0(12.5) ×(8.5)9.0–11.5(12.0) µm [Q = 1.0–1.12(1.17), **Q** = 1.07 ± 0.04], globose to subglobose, rarely broadly ellipsoid, inamyloid, colorless, hyaline, thin-walled, smooth; apiculus small.

**Material examined:** JILIN PROV: Antu County, Mt. Changbai, Y. Wang 79399 and 820611 (IFP).

**Observations:** Wang 79399 and 820611 were regarded as *A. fulva* and A. *vaginata* separately by Xie *et al.* (1986). In fact, they are conspecific with S. C. Teng 1107 (BPI 751431, CUP-CH 897), an undescribed species similar to *A. fulva* (Yang, 2000). The taxonomy of this species will be discussed in detail in another paper.

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# LIMACELLA TAIWANENSIS, A NEW SPECIES OF AGARICALES[*]

ZHU L. YANG
Kunming Institute of Botany, Academia Sinica, Kunming 650204
E-mail: zlyang@public.km.yn.cn

W. N. CHOU
National Museum of Natural Science, Taichung 404
E-mail: cwn@mail.nmns.edu.tw

**Abstract:** A new species, *Limacella taiwanensis* is described and illustrated. It is characterised by its brownish yellow to yellow pileus with a blackish brown disc, a subviscid stipe with a subglobose base, the absence of an annulus, and small, verruculose basidiospores. It belongs in the section *Limacella*.

**Key words:** Amanitaceae, systematics, Taiwan

While studying the Amanitaceae in East Asia, we have found an undescribed species of the genus *Limacella* Earle. It is reported herein. Color codes of the form "6F6" are from Kornerup & Wanscher (1981); Color names with first letters capitalized (*e.g.*, Raw Umber) are from Ridgway (1912).

***Limacella taiwanensis*** Zhu L. Yang & W. N. Chou, sp. nov. FIGS. 1–4

*Pileus 3.5–6.5 cm latus, convexus vel plano-convexsus, interdum subumbonatus, disco atrobrunneo; margine non striata, brunneoflava vel flava. Lamellae liberae, albae vel albidae, confertae, lamellulis attenuatis. Stipes 5–9 × 0.5–1 cm, subcylindricus vel sursum attenuatus, albidus vel brunneolus, subviscidus; bulbo subgloboso, 0.7–1.5 cm lato. Annulus absentes. Caro alba. Basidia 20–30 × 5–6.5 µm, 4-sporigera. Basidiosporae (3.0–) 3.5–4.0 (–4.5) × 3.0–3.5 µm, subglobosae vel latoellipsoideae, non amyloideae, non dextrinoideae. Fibulae presentes. Holotypus: W. N. Chou 00475 (TNM-F0002190), 25. V. 1994, Hsinchu, Taiwan.*

Etymology: "*taiwanensis*" referring to Taiwan, where the holotype was

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collected.

**Basidiocarps** small to medium-sized (fig. 1). **Pileus** 3.5–6.5 cm in diameter, convex to plano-convex, sometimes subumbonate, smooth, blackish brown [6F6–8; Raw Umber, Brussels Brown, Warm Sepia] at disc, becoming brownish yellow to yellow [3A4–6, 4A4–6; Buff-Yellow to Light Cadmium] towards pileal margin, strongly viscid; margin non-striate. **Lamellae** free, white to whitish, crowded; lamellulae attenuate to round attenuate, evenly distributed. **Stipe** 5–9 × 0.5–1 cm, subcylindric, whitish to brownish, farinose at apex, becoming fibrillose and subviscid in the lower part, fistulous; base somewhat enlarged, subglobose, 0.7–1.5 cm in diameter. **Annulus** absent. **Smell** unknown.

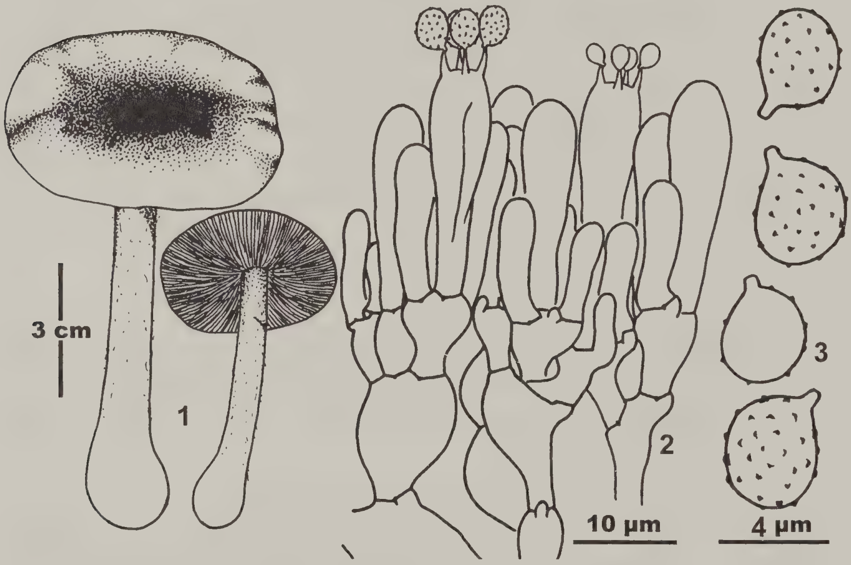

**Fig. 1–3:** *Limacella taiwanensis* (holotype).
1. Basidiocarps; 2. Hymenium and subhymenium; 3. Basidiospores.

**Lamellar trama** bilateral. **Mediostratum** 30–50 µm wide, comprising fairly abundant to abundant, filamentous hyphae 2–7 µm wide, mixed with subfusiform to ellipsoid inflated cells (70–90 × 10–20 µm); vascular hyphae rare. **Lateral stratum** composed of filamentous hyphae 2–7 µm wide, mixed with fusiform to ellipsoid, inflated cells (60–90 × 12–20 µm), diverging at an angle of 30°–45°(–60°) to the mediostratum; septa often with clamps. **Subhymenium** (fig. 2) 30–40 (–50) µm thick, with 2–3 (–4) layers of subglobose to ellipsoid or irregularly shaped, inflated cells (10–20 × 8–17 µm), occasionally mixed with barely inflated elements 3–7 µm wide. **Basidia** (fig. 2) 20–30 × 5–6.5 µm, clavate, 4-spored, rarely 1-spored; sterigmata 2–3 (–4) µm long; basal septa often with clamps. **Basidiospores** (fig. 3) [40/2/1][1] (3.0–) 3.5–4.0 (–4.5) × 3.0–3.5 µm [Q = (1.0–) 1.09–1.25, **Q** = 1.14 ± 0.06], subglobose to hyaline, thin-walled, verruculose, inamyloid, non-dextrinoid; apiculus relatively large. **Pleurocystidia** not present. **Lamellar edge** fertile, without cheilocystidia. **Pileipellis** (fig. 4) a 70–120 µm thick ixotrichodermium, comprising ± vertically arranged, colorless to yellowish brown vacuolar pigmented, sometimes finely encrusted, subcylindric, septate, branching hyphae, the terminal cells of which are subcylindric to very narrowly clavate, 30–70 × 2–7.5 µm, embedded in a gelatinized matrix; the branching hyphae

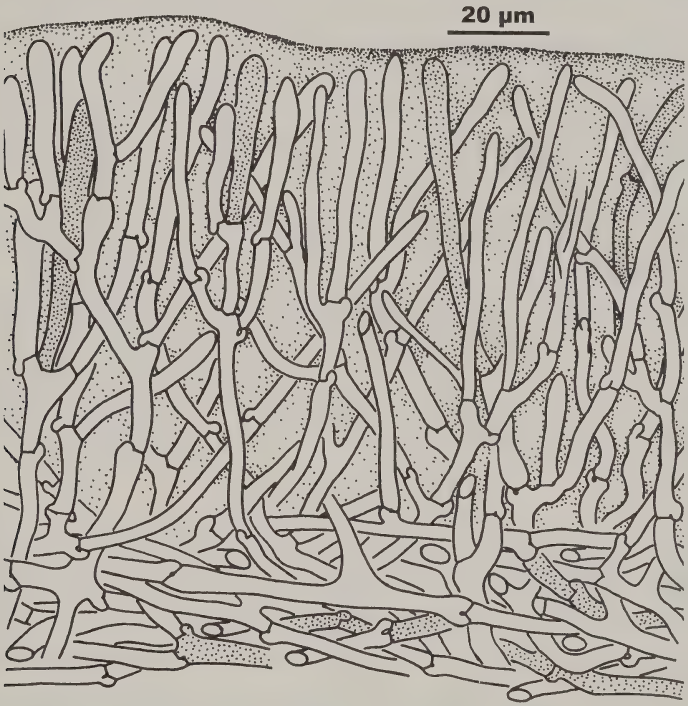

**Fig. 4:** Pileipellis and hypodermium of *Limacella taiwanensis* (holotype).

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[1] 40 basidiospores from 2 basidiocarps of 1 collection measured in 5% KOH solution; Q is used to mean "length/width ratio" of a spore; **Q** means average Q of all spores ± sample standard deviation.

arising from 10–30 µm thick hypodermium (fig. 4) of compacted and subradially arranged, colorless or sometimes yellowish brown vacuolar pigmented, filamentous hyphae 2–5 µm wide; septa often with clamps. **Stipe trama** composed of longitudinally arranged hyphae 3–20 µm wide, mixed with scattered to fairly abundant, subclavate, terminal cells (150–250 × 15–45 µm), thin-walled, hyaline; vascular hyphae rare; septa often with clamps.

**Material examined:** TAIWAN: Hsinchu County, Ssumakussushan (24.35° N, 121.20° E), alt. 1600 m, on soil, 25-V-1994, W.N. Chou 00475 (TNM-F0002190, holotype).

**Observations:** *Limacella taiwanensis* is characterised by its brownish yellow to yellow pileus with a blackish brown disc, a subviscid stipe with a subglobose base, the absence of an annulus, and small, verruculose basidiospores. It belongs in the section *Limacella* (Singer, 1986). *Limacella taiwanensis* may be related to *L. singaporeana* Corner (1994). However, *L. taiwanensis* differs from the latter by its stouter basidiocarp with a differently colored pileus, proportionally shorter spores, and thicker pileipellis. *Limacella ochraceolutea* P. D. Orton, originally described from Europe, somewhat resembles *L. taiwanensis*, but the former has much more strongly viscid pileal and stipe surfaces with a significantly paler colored pileus, a non-bulbous base of stipe, and somewhat longer basidiospores with a higher Q (Orton, 1969; Breitenbach & Kränzlin, 1995).

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# CORTICIOID FUNGI (BASIDIOMYCETES) COLLECTED IN SICHUAN PROVINCE, CHINA

**NITARO MAEKAWA**

Tottori Mycological Institute
Kokoge-211, Tottori 689-1125, Japan

and

**ZHU L. YANG, MU ZANG**

Cryptogamic Herbarium, Kunming Institute of Botany, Academia Sinica
Heilongtan, Kunming 650204, Yunnan, China

## ABSTRACT

One hundred thirteen corticioid species belonging to 46 genera (Aphyllophorales, Basidiomycotina) are reported based on the specimens collected in Sichuan Province, China, during the 1998–2000 Japan–China Joint Scientific Expedition. Among them, 40 species are new records from mainland China. For these species, taxonomically main characters and distributions are provided.

**Key words**: Corticiaceae, systematics, wood decaying fungi.

Mycofloral studies on Corticiaceae *sensu lato* (Basidiomycotina) in Sichuan Province located in southwestern part of China are still fragmentary and insufficient although several species have been treated in the published contributions (Tai, 1979; Teng, 1996; Ying, 1980; Zang, 1996).

During the 1998–2000 Japan-China Joint Scientific Expedition, organized by the National Science Museum, Tokyo, more than 400 specimens of the Corticiaceae were collected in Sichuan Province in 1999. In the taxonomical study on these specimens, we

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Paper No. 352 of the Tottori Mycological Institute.

recognized 113 species belonging to 46 genera until now. The following list is part of an ongoing documentation of biodiversity of corticioid fungi in the province. On the list, number in parentheses corresponds to collecting site of each specimen. Forty species with asterisks are new records from mainland China. For these species, taxonomically main characters and distributions are provided. Duplicates of all specimens examined in this study are deposited in the cryptogamic herbarium of the Kunming Institute of Botany (HKAS), the National Science Museum, Tokyo (TNS) and the Tottori Mycological Institute (TMI).

## Collecting sites in Sichuan Province

1. Gaoping (Yanbian Lengshuiqing forest park, N26°47' E101°31', 2,355–2,370 m alt.), Yanbian Co., Panzuihua, 17 Sept. 1999.
2. Mt. Lushan (27°51'N, 102°16'E, 2,065–2,135 m alt.), Xichang City, Liangshan, 19 Sept. 1999.
3. N slope of Mt. Luoji (27°42'N, 102°18'E, 1,950 m alt.), Xichang City, Liangshan, 20 Sept. 1999.
4. N slope of Mt. Luoji (27°41'N, 102°20'E, 2,000–2,135 m alt.), Xichang City, Liangshan, 20 Sept. 1999.
5. Daqing (N slope of Mt. Luoji, 27°45'N, 102°20'E, 2,205–2,245 m alt.), Xichang City, Liangshan, 21 Sept. 1999.
6. Lingshan Temple (28°33'N, 102°17'E, 2,380 m alt.), Mianning Co., Liangshan, 22 Sept. 1999.
7. Near the pass to Mianning Co. (28°33'N, 102°17'E, 2380 m alt.), Shimian Co., Yaan, 22 Sept. 1999.
8. Mt. Niba (near Apingguan, 29°43'N, 102°37'E, 1,530 m alt.), Yingjing Co., Yaan, 23 Sept. 1999.
9. Mt. Mengding (30°05'N, 103°03'E, 1,410 m alt.), Mingshan Co., Yaan, 24 Sept. 1999.
10. Mt. Wawu (29°39'N, 102°55'E, 2,700 m alt.), Hongya Co., Meishan, 26 Sept. 1999.
11. Mt. Wawu (E slope, 29°40'N, 102°57'E, 1,960 m alt.), Hongya Co., Meishan, 27 Sept. 1999.
12. N slope of Mt. Emei (29°36'N, 103°21'E, 1,000 m alt.), Emeishan City, Leshan, 1 Oct. 1999.
13. N slope of Mt. Emei (29°36'N, 103°15'E, 1,300 m alt.), Emeishan City, Leshan, 1 Oct. 1999.
14. Near Huangwan (N slope of Mt. Emei, 29°35'N, 103°25'E, 670 m alt.), Emeishan City, Leshan, 1 Oct. 1999.
15. Mt. Qingcheng (W slope, 30°55'N, 103°29'E, 920–1,000 m alt.), Dujiangyan City, Chengdu, 4 Oct. 1999.
16. Mt. Qingcheng (W slope, 30°55'N, 103°29'E, 1,100–1,400 m alt.), Dujiangyan City, Chengdu, 5 Oct. 1999.
17. Shidaguan (31°55'N, E103°40', 1,770 m alt.), Mao Co., Aba, 7 Oct. 1999.
18. 20 km E of Chuanxi Temple (N32°45' 103°39'E, 3,280 m alt.), Songpan Co., Aba, 8 Oct. 1999.

19. Huanglong (32°45'N, 103°49'E, 3,080 m alt.), Songpan Co., Aba, 8 Oct. 1999.
20. 20 km W of Huanglong (32°45'N, 103°41'E, 3,890 m alt.), Songpan Co., Aba, 9 Oct. 1999.
21. near the pass to Songpan Co. (33°03'N, 103°44'E, 3,300 m alt.), Jiuzhaigou Co., Aba, 10 Oct. 1999.
22. 20 km N of the pass to Songpan Co. (33°08'N, 103°43'E, 2,900 m alt.), Jiuzhaigou Co., Aba, 10 Oct. 1999.
23. 20 km N of the pass to Songpan Co. (33°13'N, 103°44'E, 2,660 m alt.), Jiuzhaigou Co., Aba, 10 Oct. 1999.
24. Yangshan (33°00'N, 104°13'E, 1,760 m alt.), Jiuzhaigou Co., Aba, 12 Oct. 1999.
25. The pass to Pingwu (32°54'N, 104°16'E, 3,260 m alt.), Jiuzhaigou Co., Aba, 12 Oct. 1999.
26. Muzhuo (32°43'N, 104°24'E, 1,750 m alt.), Pingwu Co., Mianyang, 12 Oct. 1999.
27. Mt. Douchuan (31°55'N, 104°48'E, 900–1,000 m alt.), Jiangyou City, Mianyang, 14 Oct. 1999.

## Enumeration of corticioid species found in Sichuan Province

*****Aleurodiscus canadensis*** Skolko, Canad. J. Res., Sect. C 22: 258, 1944.

Specimens examined: TMI25011 on decaying branch of *Abies forrestii* (living tree) (22); TMI25061 on decaying branch of *Picea asperata* (18). According to Núñez and Ryvarden (1997), *A. canadensis* has previously been known from Canada, U.S.A. and eastern Russia (Sakhalin Island). This species is microscopically characterized by its large subcylindric, thin-walled, smooth basidiospores measuring 16–18 × 9–12 μm and nodose-septate hyphae.

****Aleurodiscus grantii*** Lloyd, Mycol. Writ. 6 (Note 62): 927, 1920.

Specimens examined: TMI25155, 25156, 25157 and 25180 on decaying branch of *Abies fabri* (living tree) (10). This species differs from *A. amorphus* (Pers.: Fr.) Schröt. in having clamp connections at the base of basidia and sometimes in the hymenial hyphae. It was known from North America and Japan.

****Aleurodiscus parvisporus*** Núñez & Ryvarden, Synopsis Fungorum 12: 117, 1997.

Specimen examined: TMI25036 on decaying bark of *Salix* sp. (20). This is second report of *A. parvisporus*, previously known only from Japan (Núñez and Ryvarden, 1997). Diagnostic characters of this species are small and smooth basidiospores measuring 5–6 × 4–5 μm and densely spiny acanthophyses.

***Aleurodiscus subcruentatus*** (Berk. & M.A. Curtis) Burt, Ann. Missouri. Bot. Gard. 7: 237, 1920.

Specimen examined: TMI25158 on living trunk of *Abies fabri* (10).

***Amphinema byssoides*** (Pers.: Fr.) J. Erikss., Symb. Bot. Upsal. 16(1): 112, 1958.

Specimens examined: TMI25265 on decaying wood of *Pinus yunnanensis* (4); TMI25045, 25047, 25049, 25050, 25051 and 25052 on decaying branch of a coniferous tree (18); TMI25064 on decaying trunk of *Picea asperata* (18); TMI25046 on decaying wood of a coniferous tree (19); TMI25048 on decaying and decorticated branch of a coniferous tree (19); TMI25062 and 25063 on decaying branch of *P.*

*asperata* (20); TMI25083 on decaying bark of a coniferous tree (21); TMI25087 on decaying trunk of a coniferous tree (21); TMI25002 and 25003 on decaying branch of a coniferous tree (22); TMI25001 on decaying branch of a broad-leaved tree (22); TMI25022, 25082 and 25088 on decaying wood of a coniferous tree (23).

****Amphinema diadema*** K.H. Larss. & Hjortstam, Mycotaxon 26: 438, 1986.

Specimen examined: TMI25023 on decaying wood of a coniferous tree (21). Distinguishing characteristics of this species are subfusiform leptocystidia, 45–80 × 5–8 $\mu$m, and narrowly ellipsoid basidiospores, 4.5–5.5 × 2.5–3 $\mu$m. It has hitherto been known from Norway, Poland and Sweden (Hjortstam and Larsson, 1986), and therefore the Sichuan specimen represents the first record of *A. diadema* outside Northern Europe.

****Amylostereum laevigatum*** (Fr.) Boidin, Rev. Mycol. (Paris) 23: 345, 1958.

Specimen examined: TMI25301 on decaying branch of a coniferous tree (2). This species is widely distributed in the temperate regions and microscopically characterized by possessing lamprocystidia and ellipsoid to cylindrical, amyloid basidiospores measuring 7–10 × 3–4 $\mu$m.

***Athelia laxa*** (Burt) Jülich, Willdenowia, Beih. 7: 90, 1972.

Specimens examined: TMI25452 on living trunk of a broad-leaved tree (9); TMI25433 on decaying branch of a broad-leaved tree (15).

****Athelopsis glaucina*** (Bourdot & Galzin) Parmasto, Consp. Syst. Cort., 42, 1968.

Specimen examined: TMI25374 on decaying twig of a broad-leaved tree (2). Basidiospores (7–8.5 × 2–2.5 $\mu$m) of the Sichuan specimen are shorter than those (9–10 × 2–2.5 $\mu$m) described by Eriksson and Ryvarden (1973) but all the other characteristics are identical to their description. It has been reported from Africa, Europe and South America.

****Aphanobasidium bisterigmaticum*** Boidin & Gilles, Mycotaxon 75: 380, 2000.

Specimen examined: TMI25411 on decaying branch of a bamboo (12). This species was recently reported from Réunion (Boidin and Gilles, 2000), and therefore the Sichuan specimen represents the second record for the species. The major diagnostic features are two-sterigmate basidia and ellipsoid to subcylindrical, smooth, non-amyloid basidiospores measuring 8–10 × 5–5.5 $\mu$m.

****Basidioradulum radula*** (Fr.: Fr.) Nobles, Mycologia 59: 192, 1967.

Specimens examined: TMI25441 on decaying branch of a broad-leaved tree (9); TMI25404 on decaying branch of a broad-leaved tree (13). Although the hymenial surface of *B. radula* varies in appearance, this species is microscopically characterized by its cylindrical leptocystidia with several constrictions, and cylindrical to suballantoid basidiospores measuring 7.5–12 × 3–3.5 $\mu$m. It seems to be a common species in the temperate regions.

***Boidinia furfuracea*** (Bres.) Stalpers & Hjortstam, Mycotaxon 14: 77, 1982.

Specimen examined: TMI25163 on decaying trunk of *Abies fabri* (10).

***Botryobasidium pruinatum*** (Bres.) J. Erikss., Svensk Bot. Tidskr. 52: 9, 1958.

Specimens examined: TMI25317 on decaying branch of *Pinus yunnanensis* (5); TMI25057 on decaying branch of *Salix* sp. (19).

***Botryobasidium subcoronatum*** (Höhn. & Litsch.) Donk, Meded. Ned. Mycol. Ver. 18–20: 117, 1931.

Specimens examined: TMI25255 on decaying trunk of *Pinus yunnanensis* (4);

TMI25159 on decaying branch of *Abies fabri* (10); TMI25161 on decaying wood of *A. fabri* (10).

***Botryobasidium vagum*** (Berk. & M.A. Curtis) D.P. Rogers, Stud. Nat. Hist. Iowa Univ. 17: 17, 1935.

Specimens examined: TMI25247 on decaying and decorticated branch of *Pinus yunnanensis* (3); TMI25248 on decaying branch of a broad-leaved tree (3); TMI25253 on decaying wood of *P. yunnanensis* (4); TMI25254 on decaying trunk of *P. yunnanensis* (4); TMI25160 on decaying branch of *Abies fabri* (10); TMI25171, 25172, 25173 and 25174 on decaying branch of *Rhododendron* sp. (10). This species was reported as *B. botryosum* (Bres.) J. Erikss. from Yunnan Province (Maekawa and Zang, 1995).

***Botryohypochnus isabellinus*** (Fr.) J. Erikss., Svensk Bot. Tidskr. 52: 2, 1958.

Specimen examined: TMI25256 on decaying trunk of *Pinus yunnanensis* (4).

***Brevicellicium olivascens*** (Bres.) K.H. Larss. & Hjortstam, Mycotaxon 7: 119, 1978.

Specimen examined: TMI24145 on decaying branch of a broad-leaved tree (28). This species is known as *Grandinia mutabilis* (Pers.) Bourd. & Galz. in China (Ying, 1980).

*****Candelabrochaete verruculosa*** Hjortstam, Mycotaxon 17: 566, 1983.

Specimen examined: TMI25108 on decaying and decorticated branch of a broad-leaved tree (16). This species differs from the other taxa of *Candelabrochaete* in its odontoid basidiomata and thin-walled hyphae and cystidia. The species has been reported from Africa, Asia [Japan (Maekawa, 1993)], Europe and South America.

*****Ceraceomyces serpens*** (Tode: Fr.) Ginns, Canad. J. Bot. 54: 147, 1976.

Specimen examined: TMI25321 on decaying branch of *Pinus yunnanensis* (5). This species is a widely distributed taxon and is microscopically characterized by narrowly ellipsoid basidiospores, 3.5–5 × 1.5–2.5 μm, and the lack of cystidia.

***Ceraceomyces sublaevis*** (Bres.) Jülich., Willdenowia, Beih. 7: 147, 1972.

Specimens examined: TMI25117 on decaying trunk of a broad-leaved tree (16); TMI25080 on decaying branch of a broad-leaved tree (23).

***Ceraceomyces tessulatus*** (Cooke) Jülich, Willdenowia, Beih. 7: 154, 1972.

Specimens examined: TMI25025 and 25026 on decaying wood of a coniferous tree (21); TMI25017 on decaying branch of *Salix* sp. (23).

***Cylindrobasidium laeve*** (Pers.: Fr.) Chamuris, Mycotaxon 20: 587, 1984.

Specimens examined: TMI25334 on decaying twig of a broad-leaved tree (6); TMI25478 on decaying branch of a broad-leaved tree (25); TMI25142 on decaying branch of a broad-leaved tree (27).

*****Cylindrobasidium torrendii*** (Bres. in Torrend) Hjortstam, Mycotaxon 17: 571, 1983.

Specimens examined: TMI25457 on decaying trunk of *Betula delavayi* (11); TMI25144 on decaying trunk of a broad-leaved tree (27). This species is known from temperate to tropical regions. Basidiospores (6–7 × 4–4.5 μm) of the species are smaller than those (8–10.5 × 4–6 μm) of *C. laeve*.

***Cytidia salicina*** (Fr.) Burt, Ann. Missouri Bot. Gard. 11: 10, 1924.

Specimens examined: TMI25344 on decaying branch of *Salix* sp. (living tree) (6); TMI25068 and 25069 on decaying twig of *Salix paraplesia* (18); TMI25040 on decaying twig of *Salix* sp. (20); TMI25041, 25042 and 25043 on decaying branch of *Salix* sp. (20).

*****Dacryobolus sudans*** (Alb. & Schwein.: Fr.) Fr., Summa veg. Scand. 2: 404, 1849

Specimens examined: TMI25016 on decaying and decorticated branch of a coniferous tree (23); TMI25465 on decaying wood of a broad-leaved tree (25). This species is readily distinguishable from *D. karstenii* (Bres.) Oberw. & Parmasto, which is the type species of the genus, by its odontoid hymenial surface and lack of the thick-walled cystidia. It is widespread in the world.

***Duportella trigonosperma*** (Boidin, Lanquetin & Gilles) Hjortstam, Windahlia 17: 58, 1987.

Specimen examined: TMI25408 on decaying petiole of a palm (12).

***Gloeocystidiellum porosum*** (Berk. & M.A. Curtis) Donk, Meded. Ned. Mycol. Ver. 18–20: 156, 1931.

Specimens examined: TMI25460 on decaying branch of a broad-leaved tree (24) TMI24147 on decaying branch of a broad-leaved tree (27).

***Gloiothele citrina*** (Pers.) Ginns & G.W. Freeman, Biblioth. Mycol. 157: 55, 1994.

Specimens examined: TMI25030 on decaying trunk of a coniferous tree (21); TMI25164 on decaying trunk of *A. fabri* (living tree) (10).

***Hyphoderma argillaceum*** (Bres.) Donk, Fungus 27: 14, 1957.

Specimen examined: TMI25296 on decaying branch of *Keteleeria evelyniana* (2).

****Hyphoderma clavatum*** Sheng H. Wu, Bot. Bull. Acad. Sin. 38: 64, 1997.

Specimen examined: TMI25287 on decaying branch of *Quercus franchetii* (2). This is second report of *H. clavatum*, previously known from Taiwan, China (Wu, 1997) and is characterized by its clavate cystidia and cylindrical basidiospores, 10–12 × 4–5 $\mu$m.

***Hyphoderma cremeoalbum*** (Höhn. & Litsch.) Jülich, Persoonia 8: 80, 1974.

Specimen examined: TMI25354 on decaying branch of a broad-leaved tree (1).

****Hyphoderma cylindrocystidiatum*** Boidin & Gilles, Cryptog. Mycol. 12: 107, 1991.

Specimen examined: TMI25361 on decaying wood of a broad-leaved tree (1). This species is known only from the type locality in Réunion and is distinguishable from other members of the genus by its projecting encrusted leptocystidia, 50–85 × 8–12 $\mu$m, and narrowly ellipsoid to subcylindrical basidiospores, 8–9.5 × 4.5–5 $\mu$m.

****Hyphoderma mirabile*** (Parmasto) Jülich, Persoonia 8: 80, 1974.

Specimen examined: TMI25007 on decaying branch of a coniferous tree (22). This is second report of *H. mirabile*, previously known from Estonia (Parmasto, 1968). The species is characterized by its basidiomata with white hyphal strands and microscopically by having cylindrical cystidia usually with a nodose-septum and cylindrical basidiospores measuring 8–9 × 3–3.5 $\mu$m.

****Hyphoderma pallidum*** (Bres.) Donk, Fungus 27: 15, 1957.

Specimen examined: TMI25261 on decaying and decorticated trunk of *Pinus yunnanensis* (4). This species appears to be mainly distributed in temperate regions and easily recognized by its fusiform leptocystidia, 35–60 × 5.5–7.5 $\mu$m, and cylindrical to suballantoid basidiospores, 9–10.5 × (2.5–)3(–3.5) $\mu$m.

***Hyphoderma praetermissum*** (P. Karst.) J. Erikss. & A. Strid, Cort. N. Europe Vol. 3, 505, 1975.

Specimens examined: TMI25359 on decaying wood of a broad-leaved tree (1); TMI25279 on decaying branch of *Quercus* sp. (2); TMI25298 on decaying twig of *Pinus yunnanensis* (2); TMI25313 on decaying and decorticated branch of *P. yunnanensis* (5); TMI25444 on decaying wood of a broad-leaved tree (9); TMI25121 on decaying and decorticated branch of a broad-leaved tree (16); TMI25472 on decaying branch of a broad-leaved tree (26).

***Hyphoderma puberum*** (Fr.) Wallr., Fl. Crypt. Germany 2: 576, 1833.

Specimens examined: TMI25315 on decaying and decorticated trunk of *Pinus yunnanensis* (5); TMI25148 on decaying log of a coniferous tree (27).

***Hyphoderma rude*** (Bres.) Hjortstam & Ryvarden., Mycotaxon 10: 275, 1980.

Specimens examined: TMI25443 on decaying trunk of a broad-leaved tree (9); TMI 25114 on decaying branch of a broad-leaved tree (16).

***Hyphoderma setigerum*** (Fr.) Donk, Fungus 27: 15, 1957.

Specimens examined: TMI25347 and 25348 on decaying branch of a broad-leaved tree (1); TMI25267, 25268, 25271, 25274, 25275 and 25276 on decaying branch of *Quercus* sp. (2); TMI25269 on decaying twig of *Quercus* sp. (2); TMI25135 on decaying stump of *Pinus densata* (2); TMI25270, 25272 and 25273 on decaying twig of a broad-leaved tree (2); TMI25257 and 25258 on decaying and decorticated trunk of *P. yunnanensis* (4); TMI25325 on decaying twig of a broad-leaved tree (5); TMI25439 on decaying branch of a broad-leaved tree (9); TMI25440 on decaying trunk of a broad-leaved tree (9); TMI25409 on decaying twig of *Cryptomeria fortunei* (12); TMI25417 and 25418 on decaying branch of a broad-leaved tree (15); TMI25094 and 25118 on decaying branch of a broad-leaved tree (16); TMI25131 and 25133 on decaying twig of a broad-leaved tree (27); TMI 25132 on decaying branch of a broad-leaved tree (27).

***Hyphoderma sibiricum*** (Parmasto) J. Erikss. & A. Strid, Cort. N. Europe Vol. 3, 535, 1975.

Specimen examined: TMI25154 on decaying and decorticated branch of *Abies fabri* (10).

****Hyphodermella corrugata*** (Fr.) J. Erikss. & Ryvarden, Cort. N. Europe Vol. 3, 579, 1976.

Specimen examined: TMI25461 on decaying twig of a broad-leaved tree (24). This species is widespread from temperete to subtropical regions. It is characterized by its grandinioid to odontoid hymenial surface and wart-like aculei, usually with fascicles of encrusted hyphae at the apex.

****Hyphodontia alba*** Sheng H. Wu, Acta Bot. Fenn. 142: 85, 1990.

Specimen examined: TMI25422 on decaying twig of a broad-leaved tree (15). This species has hitherto been known only from Taiwan of China and Italy (Langer, 1994) and can be distinguished from other species of *Hyphodontia* by having both septate and capitate cystidia.

***Hyphodontia alutaria*** (Burt) J. Erikss., Symb. Bot. Upsal. 16: 104, 1958.

Specimens examined: TMI25162 on decaying and decoricated branch of *Abies fabri* (living tree) (10); TMI25136 on decaying trunk of a coniferous tree (27).

***Hyphodontia arguta*** (Fr.) J. Erikss., Symb. Bot. Upsal. 16: 104, 1958.

Specimens examined: TMI25098 on decaying stump of a broad-leaved tree (16); TMI25149 on decaying log of a coniferous tree (27).

***Hyphodontia boninense*** (S. Ito & S. Imai) N. Maek., Rep. Tottori Mycol. Inst. 31: 9, 1993.

Specimens examined: TMI25419 and 25420 on decaying branch of a broad-leaved tree (15); TMI25421 on decaying petiole of a palm (15); TMI25471 on decaying branch of a broad-leaved tree (26); TMI25138 on decaying trunk of a coniferous tree (27).

****Hyphodontia crustosa*** (Pers.: Fr.) J. Erikss., Symb. Bot. Upsal. 16: 104, 1958.
Specimens examined: TMI25306 on decaying branch of *Quercus* sp. (4); TMI25332 on decaying branch of a broad-leaved tree (6); TMI25442 on decaying branch of a broad-leaved tree (9); TMI25398 on decaying branch of a broad-leaved tree (13); TMI25399 on decaying twig of a broad-leaved tree (13); TMI25055 on decaying branch of a coniferous tree (20); TMI25008 and 25009 on decaying and decorticated branch of a coniferous tree (22); TMI25459 on decaying branch of a broad-leaved tree (24). This species is widespread from tropical to cold temperate regions. Diagnostic characters of *H. crustosa* are subulate leptocystidia and narrowly ellipsoid basidiospores measuring 5.5–6.5 × 2.5(–3) μm.

****Hyphodontia fimbriata*** Sheng H. Wu, Acta Bot. Fenn. 142: 90, 1990.
Specimen examined: TMI25455 on decaying trunk of a broad-leaved tree (11). This is second report of *H. fimbriata*, previously known only from Taiwan, China (Langer, 1994). The major diagnostic characteristics of the species are odontoid hymenial surface, capitate cystidia, 20–60 × 4–6 μm, and broadly ellipsoid basidiospores, 5–7 × 3.5–4.5 μm.

***Hyphodontia flavipora*** (Cooke) Sheng H. Wu, Mycotaxon 76: 54, 2000.
Specimens examined: TMI25424 on decaying branch of a broad-leaved tree (15); TMI25425 on decaying trunk of a broad-leaved tree (15).

***Hyphodontia granulosa*** (Pers.: Fr.) Ginns & M.N.L.Lefebvre, Mycol. Mem. 19: 88, 1993.
Specimens examined: TMI25312 on decaying and decorticated branch of *Pinus yunnanensis* (5); TMI25032 on decaying wood of a coniferous tree (21); TMI25153 on decaying twig of a broad-leaved tree (26). In China, this species has been known as *Odontia aspera* (Fr.) Bourdot & Galzin (Ying, 1980) or *Hyphodontia aspera* (Fr.) J. Erikss. (Hjortstam and Ryvarden, 1988).

****Hyphodontia nespori*** (Bres.) J. Erikss. & Hjortstam, Cort. N. Europe Vol. 4, 655, 1976.
Specimens examined: TMI25358 on decaying wood of a broad-leaved tree (1); TMI25327 on decaying branch of *Pinus yunnanensis* (5); TMI25328, 25329 and 25330 on decaying branch of a broad-leaved tree (7); TMI25445 on decaying branch of a broad-leaved tree (9); TMI25166 on decaying wood of *Abies fabri* (10); TMI25402 on decaying branch of a broad-leaved tree (13); TMI25095 and 25097 on decaying and decorticated trunk of a broad-leaved tree (16); TMI25096 on decaying branch of a broad-leaved tree (16). This species is common and widespread from tropical to cold temperate regions. It is microscopically characterized by capitate leptocystidia, 20–50 × 3–5 μm, and ellipsoid to subcylindrical basidiospores, 4.5–5.5 × 2–2.5(–3) μm.

***Hyphodontia pallidula*** (Bres.) J. Erikss., Symb. Bot. Upsal. 16: 104, 1958.
Specimens examined: TMI25311 on decaying and decorticated trunk of *Pinus yunnanensis* (5); TMI25319 on decaying trunk of *P. yunnanensis* (5); TMI25029 and 25084 on decaying wood of a coniferous tree (21).

***Hyphodontia pruni*** (Lasch) Svrcek, Ceská Mykol. 27: 204, 1973.
Specimens examined: TMI25331 on decaying branch of a broad-leaved tree (6); TMI25400 on decaying branch of a broad-leaved tree (13); TMI25100 on decaying branch of a broad-leaved tree (16); TMI25056 on decaying trunk of *Salix* sp. (19).

***Hyphodontia sambuci*** (Bres.) J. Erikss., Symb. Bot. Upsal. 16: 104, 1958.
Specimens examined: TMI25456 on decaying branch of a broad-leaved tree (11); TMI25405 on decaying branch of a broad-leaved tree (13); TMI25423 on decaying

branch of a broad-leaved tree (15); TMI25099 on decaying twig of a broad-leaved tree (16); TMI25105 and 25122 on decaying branch of a broad-leaved tree (16); TMI25120 on decaying and decorticated branch of a broad-leaved tree (16); TMI25085 on decaying branch of a broad-leaved tree (21).

****Hyphodontia serpentiformis*** Langer, Trans. Mycol. Soc. Japan 33: 404, 1992.
Specimens examined: TMI25372 on decaying twig of a broad-leaved tree (2); TMI25125 and 25428 on decaying branch of a broad-leaved tree (15). This species was known only from Canary Islands and Taiwan , China (Langer, 1994). It is primarily characterized by producing basally thick-walled basidia and ellipsoid basidiospores measuring 4.5–5 × 3.5–4 $\mu$m.

***Hyphodontia spathulata*** (Schrad.: Fr.) Parmasto, Consp. Syst. Cort., 123, 1968.
Specimen examined: TMI25367 on decaying branch of a broad-leaved tree (1).

***Hyphodontia subalutacea*** (P. Karst.) J. Erikss., Symb. Bot. Upsal. 16: 104, 1958.
Specimen examined: TMI25468 on decaying wood of *Rhododendron* sp. (25).

****Hypochnicium geogenium*** (Bres.) J. Erikss., Symb. Bot. Upsal. 16: 101, 1958.
Specimen examined: TMI25244 on decaying branch of *Pinus yunnanensis* (3). This species is distinguishable from the other species of *Hypochnicium* by its projecting subcylindrical leptocystidia and smooth ellipsoid basidiospores. It was known from Europe and North America.

***Hypochnicium globosum*** Sheng H. Wu, Acta Bot. Fenn. 142: 110, 1990.
Specimen examined: TMI25058 on decaying branch of a broad-leaved tree (19).

***Hypochnicium punctulatum*** (Cooke) J. Erikss., Symb. Bot. Upsal. 16: 101, 1958.
Specimens examined: TMI25290 on decaying branch of a broad-leaved tree (2); TMI25135 on decaying stump of *Pinus massoniana*? (27).

****Kavinia alboviridis*** (Morgan) Gilb. & Budington, J. Arizona Acad. Sci. 6: 95, 1970.
Specimens examined: TMI25035 on decaying bark of a coniferous tree (21); TMI25093 on decaying trunk of a coniferous tree (21). This species is easily recognized by having greenish colored, hydnoid hymenial surface and pale yellowish colored, thick-walled, warted, narrowly ovoid to narrowly ellipsoid basidiospores measuring 8–10 × 3–4 $\mu$m. It has been reported from Asia [India (Rattan, 1977)], Europe and North and South America.

****Leptosporomyces ovoideus*** Jülich, Willdenowia, Beih. 7: 203, 1972.
Specimens examined: TMI25070 and 25071 on decaying branch of *Picea* sp. (18); TMI25077 on decaying branch of a broad-leaved tree (19). This species is distinctive from closely related species by its ellipsoid, slightly thick-walled and smooth basidiospores measuring 3.5–4.5 × 2.5–3 $\mu$m. It has previously been known from Europe and North America.

****Leptosporomyces raunkiaerii*** (M.P. Christ.) Jülich, Willdenowia, Beih. 7: 206, 1972.
Specimen examined: TMI25264 on decaying wood of *Pinus yunnanensis* (4). This species is microscopically characterized by its nodose-septate hyphae and cylindrical basidiospores, 4–4.5 × 1.75–2 $\mu$m. It was known from Africa, Europe and North America.

****Melzericium udicolum*** (Bourdot) Hauerslev, Friesia 10: 316, 1975.
Specimen examined: TMI25470 on decaying twig of a broad-leaved tree (25). This species has been reported only from Brazil (Hjortstam and Bononi, 1987), and therefore, the Sichuan specimen represents the first record of the species outside South

America. It is easily distinguishable from a closely related species, *M. rimosum* Bononi & Hjortstam by its bean-shaped basidiospores measuring 8–10 × 3–4.5 μm.

***Mycoacia fuscoatra*** (Fr.) Donk, Meded. Ned. Mycol. Ver. 18–20: 152, 1931.

Specimen examined: TMI25413 on decaying trunk of a broad-leaved tree (14).

***Mycoacia pinicola*** J. Erikss., Svensk Bot. Tidskr. 43: 59, 1949.

Specimens examined: TMI25364 and 25365 on decaying branch of a broad-leaved tree (1); TMI25152 on decaying wood of a broad-leaved tree (26).

***Peniophora cinerea*** (Bres.) Cooke, Grevillea 8: 20, 1879.

Specimens examined: TMI25352 on decaying branch of a broad-leaved tree (1); TMI25335 on decaying branch of a broad-leaved tree (6); TMI25448 on decaying branch of a broad-leaved tree (9); TMI25426 and 25427 on decaying branch of a broad-leaved tree (15); TMI25110 on decaying branch of a broad-leaved tree (16); TMI25141, 25139 and 25140 on decaying branch of a broad-leaved tree (27).

***Peniophora incarnata*** (Pers.: Fr.) P. Karst., Hedwigia 28: 27, 1889.

Specimen examined: TMI25462 on decaying branch of a broad-leaved tree (24).

***Peniophora manshurica*** Parmasto, Biblioth. Mycol. 115: 138, 1987.

Specimen examined: TMI25249 on decaying branch of a broad-leaved tree (4).

***Peniophora rufa*** (Fr.) Boidin, Bull. Soc. Mycol. France 74: 443, 1959.

Specimens examined: TMI25038 and 25039 on decaying branch of *Salix hylonoma* (20); TMI25065 on decaying and decorticated branch of *Salix* sp. (18); TMI25066 on decaying twig of *Salix* sp. (18); TMI25067 on decaying branch of *Salix* sp. (18); TMI25037 on decaying twig of *Salix* sp. (20); TMI25479 on a decaying branch of a broad-leaved tree (24). Additional specimens: HKAS32008 (=TMI21110) on decaying branch, Reda Township (3,400 m alt.), Xiangcheng Co., 17 Jul. 1998, coll. by Zhu L. Yang; HKAS32007 (=TMI21111) on decaying twig, Riying (3,600 m alt.), Xiangcheng Co., 10 Jul. 1998, coll. by Zhu L. Yang.

****Peniophora violaceolivida*** (Sommerf.) Massee, J. Linn. Soc., Bot. 25: 152, 1890.

Specimen examined: TMI25044 on decaying branch of *Salix* sp. (20). This species is a cosmopolitan one and is characterized by having gloeocystidia, lamprocystidia and allantoid basidiospores measuring 7.5–9 × 2.5–3 μm.

***Phanerochaete chrysorhiza*** (Torr.) Budington & Gilb., SouthW. Naturalist 17: 417, 1973.

Specimen examined: TMI25351 on decaying branch of a broad-leaved tree (1).

***Phanerochaete laevis*** (Fr.) J. Erikss. & Ryvarden., Cort. N. Europe Vol. 5, 1007, 1978.

Specimen examined: TMI25454 on decaying branch of a broad-leaved tree (11).

****Phanerochaete martelliana*** (Bres.) J. Erikss. & Ryvarden, Cort. N. Europe Vol. 5, 1011, 1978

Specimens examined: TMI25362 and 25363 on decaying branch of a broad-leaved tree (1). Basidiospores (7–9.5 × 4.5–5.5 μm) of these specimens are slightly smaller than those (9–11 × 5–6 μm) described by Burdsall (1985) but all the other features are consistent with the description. This species was known from Africa, Australia and Europe.

***Phanerochaete sanguinea*** (Fr.) Pouzar, Ceská Mykol. 27: 26, 1973.

Specimens examined: TMI25357 on decaying branch of a broad-leaved tree (1); TMI25277 and 25278 on decaying branch of *Quercus* sp. (2); TMI25250 on decaying branch of *Quercus* sp. (3); TMI25326 on decaying branch of a broad-leaved tree (5); TMI25333 on decaying branch of a broad-leaved tree (6).

***Phanerochaete sordida*** (P. Karst.) J. Erikss. & Ryvarden, Cort. N. Europe Vol. 5, 1023, 1978.

Specimens examined: TMI25353 on decaying twig of a broad-leaved tree(1); TMI25243 on decaying branch of *Pinus yunnanensis* (3); TMI25266 on decaying branch of a broad leaved tree (4); TMI25435, 25436, 25437 and 25438 on decaying branch of a broad-leaved tree (9); TMI25111 on decaying branch of a broad-leaved tree (16); TMI25004 and 25005 on decaying branch of a coniferous tree (22).

***Phanerochaete viticola*** (Schwein.) Parmasto, Izv. Akad. Nauk Estonsk. S.S.R., Ser. Biol. 16: 389, 1967.

Specimens examined: TMI25176 and 25177 on decaying trunk of *Sorbus glomerulata* (10); TMI25179 on living trunk of *Rhododendron* sp. (10).

***Phlebia acerina*** Peck, New York State Bot. Rep. 42: 27, 1889.

Specimens examined: TMI25350 on decaying twig of a broad-leaved tree (1); TMI25284, 25285 and 25286 on decaying branch of *Quercus* sp. (2); TMI25336 on decaying branch of a broad-leaved tree (6).

***Phlebia albida*** H. Post, Monogr. Hym. Suec. 2: 280, 1863.

Specimen examined: TMI25072 on decaying branch of *Picea* sp. (18).

****Phlebia heterocystidia*** Sheng H. Wu, Acta Bot. Fenn. 142: 29, 1990.

Specimen examined: TMI25366 on decaying branch of a broad-leaved tree (1). The odontoid hymenial surface, halocystidia and cylindrical leptocystidia are distinct in *P. heteorcystidia.* This species has previously been reported only from Japan (Maekawa, 1993) and Taiwan, China (Wu, 1990).

***Phlebia lilascens*** (Bourdot) J. Erikss. & Hjortstam, Cort. N. Europe Vol. 6, 1123, 1981.

Specimens examined: TMI25282 and 25283 on decaying branch of *Quercus* sp. (2); TMI25245 on decaying and decorticated branch of *Pinus yunnanensis* (3).

****Phlebia livida*** (Pers.: Fr.) Bres., Atti Imp. Regia Accad. Rovereto, Ser. III 3: 105, 1897.

Specimens examined: TMI25280 on decaying twig of *Quercus* sp. (2); TMI25281 on decaying branch of *Quercus* sp.(2); TMI25078 on decaying and decorticated branch of *Picea* sp. (18). Diagnostic characters of *P. livida* are smooth to tuberculate hymenial surface, subulate leptocystidia and suballantoid basidiospores measuring 4.5–5.5 × 2–2.5 $\mu$m. This species appears to be a cosmopolitan one.

***Phlebiella allantospora*** (Oberw.) K.H. Larss. & Hjortstam, Mycotaxon 29: 318, 1987.

Specimens examined: TMI25299 on decaying branch of *Pinus yunnanensis* (2); TMI25308 on decaying branch of *P. yunnanensis* (5); TMI25447 on decaying branch of a broad-leaved tree (9).

****Phlebiella grisella*** (Bourdot) K.H. Larss. & Hjortstam, Mycotaxon 29: 318, 1987.

Specimen examined: TMI25289 on decaying branch of *Quercus* sp. (2). This species is distinguishable from the other species of *Phlebiella* by its short-allantoid to reniform, smooth and thin-walled basidiospores measuring 4–5 × 2–2.5 $\mu$m. It is probably widespread in the world but not common.

***Phlebiella insperata*** (Jacks.) Ginns & M.N.L. Lefebvre, Mycol. Mem. 19: 125, 1993.

Specimen examined: TMI25151 on decaying twig of a broad-leaved tree (26).

****Phlebiella tulasnelloidea*** (Höhn. & Litsch.) Oberw., Biblioth. Mycol. 61: 343, 1977.

Specimens examined: TMI25300 on decaying wood of a broad-leaved tree (2);

TMI25165 on decaying wood of *Abies fabri* (10); TMI25403 on decaying branch of *Cryptomeria fortunei* (13); TMI25101, 25102 and 25115 on decaying and decorticated branch of a broad-leaved tree (16); TMI25116 on decaying trunk of *Quercus* sp. (16). This species is a widely distributed taxon and is readily identified by its pleurobasidia and ellipsoid to subglobose, echinulate basidiospores.

***Piloderma byssinum*** (P. Karst.) Jülich, Ber. Deutsch. Bot. Ges. 81: 418, 1969.
Specimen examined: TMI25262 on decaying branch of *Pinus yunnanensis* (4).

***Plicatura crispa*** (Pers.: Fr.) Rea, British Basidiomycetes, 626, 1922.
Specimen examined: TMI25375 on decaying branch of a broad-leaved tree (23).

***Pulcherricium caeruleum*** (Lam.: Fr.) Parmasto, Consp. Syst. Cort., 133, 1968.
Specimens examined: TMI25345 and 25346 on decaying branch of a broad-leaved tree (1); TMI25373 on decaying branch of *Keteleeria evelyniana* (2).

***Punctularia strigosozonata*** (Schwein.) Talbot, Bothalia 7: 143, 1958.
Specimens examined: TMI25355 on decaying branch of a broad-leaved tree (1); TMI25307 on decaying branch of *Quercus* sp. (4); TMI25075 and 25076 on decaying trunk of a broad-leaved tree (17).

***Radulomyces confluens*** (Fr.: Fr.) M.P. Christ., Dansk Bot. Ark. 19: 230, 1960.
Specimens examined: TMI25473 and 25474 on decaying branch of a broad-leaved tree (26); TMI25143 on decaying twig of a broad-leaved tree (27).

***Resinicium bicolor*** (Alb. & Schwein.: Fr.) Parmasto, Consp. Syst. Cort., 98, 1968.
Specimens examined: TMI25031 and 25089 on decaying wood of a coniferous tree (21); TMI25081 on decaying trunk of a coniferous tree (21).

***Scopuloides hydnoides*** (Cooke & Massee) Hjortstam & Ryvarden, Mycotaxon 9: 509, 1979.
Specimen examined: TMI25467 on decaying wood of a broad-leaved tree (25).

***Sistotrema brinkmannii*** (Bres.) J. Erikss., Kungl. Fysiogr. Sällsk. Lund Förh. 18: 17, 1948.
Specimens examined: TMI25449 on decaying branch of a broad-leaved tree (9); TMI25453 on decaying branch of *Abies fabri*? (11); TMI25401 on decaying trunk of *Cryptomeria fortunei* (13); TMI25463 on decaying branch of a broad-leaved tree (24); TMI25466 on decaying wood of a broad-leaved tree (25); TMI25130 on decaying and decorticated trunk of a broad-leaved tree (27).

****Sistotrema coronilla*** (Höhn. & Litsch.) Donk ex D.P. Rogers, Stud. Nat. Hist. Iowa Univ. 7: 23, 1935.
Specimens examined: TMI25073 on decaying bark of *Picea* sp. (18); TMI25020 and 25021 on decaying branch of a broad-leaved tree (23). This species has previously been reported from Asia [Japan (Maekawa, 1999)], Europe and North America. The species is distinguishable from its related species by having subcylindrical to narrowly ellipsoid basidiospores measuring 5–6 × (2–)2.5 $\mu$m.

****Sistotrema estonicum*** Parmasto, Izv. Akad. Nauk Estonsk. S.S.R., Ser. Biol. 14: 230, 1965.
Specimen examined: HKAS21113 (=TMI21113) on decaying twig, Mt. Daxueshan (4,000 m alt.), Xiangcheng Co., 27 Jul. 1998, coll. by Zhu L. Yang. All the micromorphological features of the specimen are identical with those of *S. estonicum* described by Parmasto (1965). This species is primarily characterized by having narrowly ellipsoid basidiospores measuring 6–7.5 × 3–3.5 $\mu$m and has

previously been reported only from Estonia.

***Sistotrema microsporum*** N. Maek., Proc. Japan Acad., B 69: 122, 1993.

Specimen examined: TMI25291 on decaying branch of a broad-leaved tree (2).

***Sistotrema muscicola*** (Pers.) S. Lundell, Fungi Exs. Suec. No. 145, Uppsala, 1947.

Specimen examined: TMI25018 on decaying trunk of *Abies* sp. (23).

****Sistotrema oblongisporum*** M.P. Christ. & Hauerslev, Dansk Bot. Ark. 19: 82, 1960.

Specimens examined: TMI25343 on decaying twig of a broad-leaved tree (7); TMI25033 on decaying wood of a coniferous tree (21). This species has previously been known from Africa, Asia [Japan (Maekawa, 1993)], Europe and North America. *Sistotrema oblongisporum* resembles *S. brinkmannii*, but the latter produces a grandinioid hymenial surface and broader basidiospores.

***Sistotremella perpusilla*** Hjortstam, Cort. N. Europe Vol. 7, 1381, 1984.

Specimen examined: TMI25349 on decaying wood of a broad-leaved tree (1).

***Sistotremastrum suecicum*** Litsch. ex J. Erikss., Symb. Bot. Upsal. 16(1): 62, 1958

Specimen examined: TMI25260 on decaying and decorticated branch of *P. yunnanensis* (4).

***Sphaerobasidium minutum*** (J. Erikss.) Oberw. ex Jülich, Persoonia 10: 335, 1979.

Specimen examined: TMI25356 on decaying wood of *Pinus yunnanensis* (1).

***Subulicystidium longisporum*** (Pat.) Parmasto, Consp. Syst. Cort., 121, 1968.

Specimen examined: TMI25288 on decaying wood of a broad-leaved tree (2).

***Subulicystidium perlongisporum*** Boidin & Gilles, Bull. Soc. Mycol. France 104: 197, 1988.

Specimens examined: TMI25112 on decaying branch of a broad-leaved tree (16); TMI25137 on decaying wood of a broad-leaved tree (27).

***Trechispora alnicola*** (Bourdot & Galzin) Liberta, Taxon 15: 318, 1966.

Specimens examined: TMI25259 on decaying and decorticated branch of *Pinus yunnanensis* (4); TMI25106 on decaying wood of a broad-leaved tree (16); TMI25135 on decaying wood of a broad-leaved tree (27).

***Trechispora cohaerens*** (Schwein.) Jülich & Stalpers, Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., Tweede Sect. 74: 257, 1980.

Specimen examined: TMI25464 on decaying twig of a broad-leaved tree (24).

***Trechispora farinacea*** (Pers.: Fr.) Liberta, Taxon 15: 318, 1966.

Specimens examined: TMI25446 on decaying branch of a broad-leaved tree (9); TMI25397 on decaying trunk of a broad-leaved tree (13); TMI25414 and 24515 on decaying petiole of a palm (15); TMI25416 on decaying stem of a bamboo (15); TMI25109 on decaying branch of a broad-leaved tree (16).

***Trechispora mollusca*** (Pers.: Fr.) Liberta, Canad. J. Bot. 51: 1878, 1973.

Specimens examined: TMI25024 and 25028 on decaying wood of a coniferous tree (21).

****Trechispora subsphaerospora*** (Litsch.) Liberta, Canad. J. Bot. 51: 1887, 1973.

Specimens examined: TMI25103 and 25119 on decaying branch of a broad-leaved tree (16); TMI25104 on decaying and decorticated branch of a broad-leaved tree (16). This species is easily distinguishable by its turbinate to triangular and slightly thick-walled basidiospores measuring 3–4 × 2.5–3.5 $\mu$m. It has been reported from Asia [Japan (Maekawa, 1993)], Europe, and North and South America.

***Tubulicrinis calothrix*** (Pat.) Donk, Fungus 26: 14, 1956.

Specimens examined: TMI25246 on decaying and decorticated branch of *Pinus yunnanensis* (3); TMI25316 on decaying branch of *P. yunnanensis* (5).

****Tubulicrinis chaetophorus*** (Höhn.) Donk, Fungus 26: 14, 1956.

Specimen examined: HKAS32006 (=TMI21112) on decaying wood, Mt. Daxueshan (4,000 m alt.), Xiangcheng Co., 27 Jul. 1998, coll. by Zhu L. Yang. This species is readily recognized by that the lyocystidia are narrowly conical with a capillary lumen, not expanding at the apex and by ellipsoid basidiospores, 5.5–6.5 × 3–3.5 μm. It may be a widely distributed taxon.

****Tubulicrinis cinctus*** G. Cunn., New Zealand Dept. Sci. Industr. Res. Bull. 145: 142, 1963.

Specimen examined: TMI25027 on decaying wood of a coniferous tree (21). Microscopically, *T. cinctus* differs from the related species in possessing obliquely subglobose basidiospores, 4.5–5 × 3.5–4.5 μm, and cylindrical lyocystidia with a slightly widened apex. This species was known from Australasia and Europe.

***Tubulicrinis gracillimus*** (D.P. Rogers & H.S. Jacks.) G. Cunn., New Zealand Dept. Sci. Industr. Res. Bull. 145: 141, 1963.

Specimens examined: TMI25360 on decaying trunk of *Pinus yunnanensis* (1); TMI25305 on decaying and decorticated branch of *P. yunnanensis* (4); TMI25318 on decaying branch of *P. yunnanensis* (5); TMI25053 and 25054 on decaying branch of a coniferous tree (19); TMI25090 on decaying branch of *Betula* sp.? (21); TMI25006 on decaying branch of a coniferous tree (22); TMI25012 on decaying and decorticated branch of a coniferous tree (22); TMI25013 on decaying branch of a coniferous tree (*Abies*?) (23); TMI25014 and 25079 on decaying branch of *Betula* sp. (23); TMI25015 on decaying branch of *Salix* sp. (23).

***Tubulicrinis subulatus*** (Bourdot & Galzin) Donk, Fungus 26: 14, 1956.

Specimens examined: TMI25309 on decaying and decorticated branch of *Pinus yunnanensis* (5); TMI25086 on decaying wood of a coniferous tree (21).

****Xenasma rimicolum*** (P. Karst.) Donk, Fungus 27: 26, 1957.

Specimen examined: TMI25107 on decaying trunk of a broad-leaved tree (16). This species is widely distributed from tropical to cold temperate regions, and easily recognized by having tubular, thick-walled (except the apical part) cystidia and ellipsoid to subglobose basidiospores, 8.5–13.5 × 5.5–9.5 μm.

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# MYCODIVERSITY STUDIES IN SELECTED ECOSYSTEMS OF GREECE: II. MACROFUNGI ASSOCIATED WITH CONIFERS IN THE TAYGETOS MOUNTAIN (PELOPONNESE)

**Georgios I. Zervakis[1*], Dimitrios M. Dimou[2], Elias Polemis[1] & Mitko Karadelev[3]**

[1] *National Agricultural Research Foundation, Institute of Kalamata,*
*Lakonikis 85, 24100 Kalamata, Greece*
[2] *Agricultural University of Athens, Laboratory of General & Agricultural Microbiology,*
*Iera Odos 75, 11855 Athens, Greece*
[3] *Institute of Biology, Faculty of Natural Sciences and Mathematics,*
*Gazi Baba, P.O.Box 162, 1000 Skopje, FYR Macedonia*

**Abstract:** In Greece, data on macrofungi diversity is scattered and fragmentary. Recent research interest on the fungal biota of selected ecosystems begins to provide valuable information pertinent to the occurrence, frequency, distribution and ecogeography of Basidiomycotina and larger Ascomycetes. Mt. Taygetos (southern Peloponnese) constitutes one of the richest ecosystems in plant diversity in Greece. Research studies on the mycoflora associated with conifer forests of this area (mainly *Abies cephalonica* and *Pinus nigra* ssp. *pallasiana*) resulted in the recording of 265 species belonging to 123 genera (250 species and 112 genera of Basidiomycotina, and 15 and 11 genera of Ascomycotina). Among them, 68 species (together with subspecies and varieties) and 10 genera (i.e. *Geoglossum, Fayodia, Faerberia, Amylocorticium, Amphinema, Athelia, Botryobasidium, Columnocystis, Litschauerella*, and *Sistotrema*) are reported for the first time from Greece. In addition, other 85 taxa records constitute new substrate/hosts reports. Taxonomic notes and descriptions are provided for the most interesting findings, and an analysis of relevant information is presented in conjunction with ecotrophic preferences, spatial and time occurrence, and habitat.

**Keywords:** mycoflora, mushrooms, *Abies, Pinus*, Basidiomycotina

## INTRODUCTION

In Greece, the conifer forests cover a total area of ca. 1.43 million hectares and consist mainly of *Abies* spp. (*A. cephalonica, A.* x *borisii-regis* and *A. alba*: 543,000 hectares), *Pinus* spp. (*P. halepensis, P. brutia, P. nigra, P. leucodermis, P. sylvestris* and *P. pinea*: 881,000 hectares) and *Picea abies* (2,754 hectares) (Inventory of Greek Forests, National Forest Service). In Peloponnese, extensive coniferous forests dominated by either *P. nigra* or *A. cephalonica* or both occur at altitudes between ca. 600 and 1,700 m, and cover an area of approx. 163,000 hectares (ca. 75% corresponds to *A. cephalonica*). According to the Greek "Habitat" project Natura 2000, Peloponnese is the richest phytogeographical region of Greece in respect to the number of the "Important Plant Species, IPS" (i.e. taxa included in the Red Data Book of rare and threatened plants of Greece (Phitos & al. 1995), Greek endemic taxa, taxa included in the lists of

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[*] corresponding author: zervakis@kal.forthnet.gr

International Conventions, etc.), and the highest percentage of IPS are found in Mt. Taygetos.

The Mt. Taygetos covers a total area of 53,625 hectares, with an average altitude of 1,500 m (max. altitude: 2,407 m) and is classified in the Mediterranean biogeographical zone. The rocky, phrygana-maquis and sclerophyllous or evergreen shrubs habitats, which are characteristic of Mediterranean ecosystems (*Quercion ilicis* and *Ostryo-Carpinion* alleances), cover a large part of the vegetation of Mt. Taygetos (approx. 40%); whereas sub-alpine and alpine meadows cover an additional 18% of the total area. On the other hand, within the forest vegetation, the mountain biotope is characterized by the chorological type of southern Greece (Peloponnese and south-central Greece) and belongs to the *Abietion cephalonicae* phytosociety; this subzone is characterized by the typical forms of *Abies cephalonica* and *Pinus nigra* ssp. *pallasiana*, and it covers about 10% of the total Mt. Taygetos area. This particular forest presents a weak mid-mediterranean to sub-mediterranean bioclimatic type, while the soils are characterized as Luvisols and Acrisols/Cambisols.

Research on the mycoflora of Greece has been fragmentary and inadequate. Very few data exist in comparison to the knowledge accumulated so far in other European countries, which permit to derive a total of only 2,500 recorded fungal species (Zervakis 2001, Zervakis & Dimou 2000). Lately, a larger project was set up by the National Agricultural Research Foundation and the Agricultural University of Athens aiming at inventorying the fungal biota of selected ecosystems of Greece. At a preliminary stage, check-lists of Basidiomycotina and larger Ascomycetes were compiled based on a thorough evaluation and processing of existing data (Zervakis & al. 1998, Zervakis & al. 1999). This is the second in a series of reports from the surveys conducted during the recent past on Greek biotopes and the first detailed inventory of fungi from the Taygetos mountain.

## METHODOLOGY

Foraying and collecting of fungal specimens was carried out during five consecutive seasons (from late August until early June of the years 1996-97, 1997-98, 1998-99, 1999-2000 and 2000-2001). Four selected sites, each one of an estimated total area of 1 sq.km. (Fig. 1), were frequently visited (once per week) and thoroughly investigated (the site designated as "Site 1" Dyrrachi-Leontari has coordinates 37°12′38′′N-22°10′39′′E, lies to the north of the same greater area, it is dominated by oak forests and its mycological findings are to be reported in a forthcoming paper):

Site 2 (S2): along the road from Dyrrachi to Neochori (direction southeast, 2 km), altitude 900 m, coordinates 37°10′48′′N-22°12′53′′E, vegetation primarily consisting of *A. cephalonica*, *Juniperus oxycedrus* ssp. *oxycedrus* and evergreen shrubs (*Quercus coccifera*, *Pistacia lentiscus*, *Arbutus unedo*, etc.). It belongs to the Tripolis zone with flysch undivided: alternations of grey marts, sandstones with intercalations or lenses of limestones and conglomerates (Upper Eocene-Oligocene), and dolomite-bedded limestones: grey, bituminous, medium-bedded, sometimes dolomitized (Paleocene-Upper Eocene).

Site 3 (S3): along the road from the Tourist Kiosk of Taygetos to Neochori (direction north, 8 km), altitude 1,300 m, coordinates 37°07′11′′N-22°15′50′′E, vegetation primarily consisting of *P. nigra*, and *A. cephalonica*, *Q. coccifera*, *J. oxycedrus* and ferns. It belongs to the Phyllite-Quartzite series: it develops on the eastern part of the sheet, folded and overthrust on the Plattenkalk series, overlies tectonically the Tyros beds or the carbonate rocks of the Tripolis zone, consisting mainly of schists alternating with quartzites, metaconglomerates, metabasalts, marbles and a local serpentinite intercalation (data derived from the Geological Map of Greece, Kalamata Sheet).

Site 4 (S4): along the road from the Tourist Kiosk of Taygetos to Neochori (direction north, 10 km), altitude 1,400 m, coordinates 37°08′42′′N-22°15′54′′E, vegetation primarily consisting of *A. cephalonica*, and *P. nigra*, and scattered *Q. coccifera*, *Castanea sativa* and *Acer* spp. Geological data as for previous site (S3).

Site 5 (S5): along the road from the Tourist Kiosk of Taygetos to Sparti (direction northeast, 2 km), altitude 1,300 m, coordinates 37°04′33′′N-22°16′05′′E, vegetation primarily consisting of *P. nigra* with some dispersed *A. cephalonica* and deciduous trees (e.g. *Robinia pseudoacacia*). Geological data as for previous site (S3).

In addition, several other records from the Taygetos region from various localities within the administrative prefecture of Messinia are included in this report (Fig. 1).

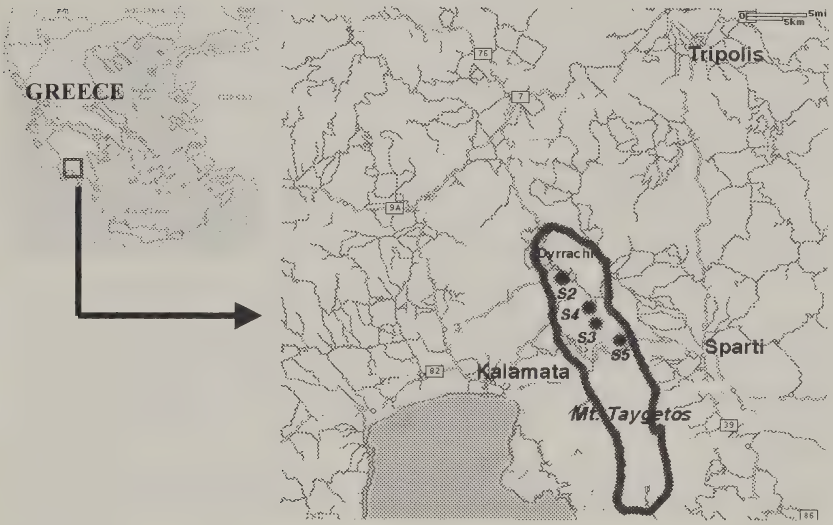

**Fig. 1.** Map of Mt. Taygetos (southern Peloponnese, Greece) illustrating the area examined for macrofungal diversity, and indicating by dots the position of the four sites (S2, S3, S4, S5) where a more detailed study was conducted.

Meteorological data were obtained from the closest station situated in the Artemisia village (Fig. 1). The weather conditions during the period of this study could be summarized as follows:

Year 1996: harsh winter and spring with heavy snowfall and rainfall, low temperatures and high air humidity ($T_m$: 4.5 °C, rain: 689.2 mm, during the first three months of this year); summer months relatively wet with high temperatures; autumn with heavy rainfalls during the entire collection period (beginning from mid-August), mild to high temperatures and high air humidity.

Year 1997: mild and dry winter and spring with particularly low rainfalls ($T_m$: 6.5 °C, rain: 74.4 mm, during the first three months of this year), dry summer with high temperatures extending until the end of September, average rainfalls with mild temperatures during October-November, heavy rainfalls and relatively mild temperatures during December ($T_m$: 8.5 °C, rain: 365 mm).

Year 1998: winter and spring with relatively low rainfalls, dry summer with high temperatures, very low rainfall and high temperatures during September and October ($T_m$: 18.9 °C, rain: 97.4 mm), relatively high rainfalls, air humidity and low temperatures in the last two months ($T_m$: 9.3 °C, rain: 495.4 mm).

Year 1999: relatively high rainfalls (rain: 602.6 mm during the first three months of the year) and air humidity accompanied with rather high temperatures in winter and spring, some rainfalls during summer, average rainfalls and high temperatures in September ($T_m$: 20.8 °C, rain: 78.8 mm), high rainfalls and air humidity during November-December (rain: 628.2 mm).

Year 2000: relatively low rainfalls during the winter and spring months, rather high temperatures in spring, no rainfall during summer, and very dry autumn months with high temperatures extending until the end of the next winter period ($T_m$: 10.1 °C, rain: 164.6 mm, from November 2000 to January 2001). In general, this year was the driest of all periods during this study.

Field parameters and macroscopic characteristics of the collected specimens were recorded *in situ*. Microscopic observations and microchemical reactions were carried out at the National Agricultural Research Foundation, Institute of Kalamata (NAGREF-IK). Additional examinations were performed (where needed) in the Laboratory of General & Agricultural Microbiology at the Agricultural University of Athens (LGAM-AUA). For the identification, field books, general and specialized keys and monographs were used (e.g. Dennis 1981, Singer 1986, Moser 1983, Bigelow 1982, 1985, van Waveren 1985, Ryvarden & Gilbertson 1993, Breitenbach & Kränzlin 1984-2001, Bas & al. 1988-1995, Hansen & Knudsen 1992, Hansen & Knudsen 1997, Eriksson & Ryvarden 1973-1976, Eriksson & al. 1978-1984, Hjortstam & al. 1987-1988, Jülich 1984).

The species are presented in alphabetical order within each genus. Nomenclature follows (with some exceptions) the guidelines of the Dictionary of Fungi (Hawksworth & al. 1995). When necessary, comments follow each species citation. Taxa reported for the first time from Greece are marked by an asterisk (*), while new habitat or host/substrate records for Greece are marked by a cross (†). All species cited in this study are deposited in the herbarium of the NAGREF-IK. A photographic archive is also maintained, and pure cultures are available for certain specimens.

The Greek geographical names are those used in the current language ("dimotiki") and their transcription into English follows the international standard ISO 843 (1997).

## DATA RECORDED

### Ascomycotina

******Geoglossum glutinosum*** Pers.
On soil in mosses, in mixed *A. cephalonica* and *Q. coccifera* forests, gregarious, end of November 1999 (S2). This rare "earth tongue" was collected only once and specimens carried the typical features of this taxon: Ascocarps with glutinous-mucilaginous surface, up to 6 cm high and 2 cm broad in the upper part, black or very dark brown colour; asci 8-spored (190-220 x 17-25 µm) and dark brown, 3-7 septate ascospores (55-90 x 5.0-6.5 µm).

**†*Geopora sumneriana*** (Cooke) M. Torre
On soil/humus/woody remains in *P. nigra* and *A. cephalonica* forests, May (S4). Rather common in Greece.

***Geopyxis carbonaria*** (Alb. & Schwein.) Sacc.
On burned ground and attached to charred wood, recorded in great numbers during spring (Zervakis & al. 1999) and autumn 1999 and 2000 (S3). Apothecia: cup –1.5(2) cm across, red-brown with ochre-whitish floccose margin; stipe 1-5 mm; ascopores: elliptical to fusiform, smooth, hyaline, 12-16 x 7-9 µm; asci: 190-220 x 10-12 µm, base often bearing 2 lobes; paraphyses: slightly clavate, some forked at base, tips 4-5 µm.

***Gyromitra esculenta*** (Pers.) Fr.
On soil in burned *P. nigra* forest, solitary, rare, collected once in May 2000 (S3).

†***Gyromitra infula*** (Schaeff.) Quèl.
On fallen trunk of *A. cephalonica*, solitary (S4), and on burned soil in *P. nigra* and *A. cephalonica* forests, gregarious in large numbers, common, September-October (S3). Relatively rare in Greece (Zervakis & al. 1999).

***Gyromitra perlata*** (Fr.) Harmaja
On mossy ground with woody remains of *A. cephalonica*, rare, collected only once in May 1999 in a mixed forest (S2). Reported twice before in the past from Greece on *A. cephalonica* (Diamandis & Minter 1983), and on *A. borisii-regis* and *Fagus* sp. (Avtzis & Diamandis 1988).

†***Helvella elastica*** Bull.
In *P. nigra* and *A. cephalonica* forests, gregarious, common, October-December (S3). Only one previous record from Greece in fir forests (Diamandis 1992).

***Helvella lacunosa*** Afz.
On mossy and stony stands in *A. cephalonica* and *J. oxycedrus* forests, common, October-November (S2). Common in Greece, mainly in coniferous habitats.

†***Helvella leucomelaena*** (Pers.) Nannf.
On soil in burned *P. nigra* forest, May 2000 (over Artemisia). Only two previous records from Greece as *Paxina leucomelas* (Pers.) Kuntze (Pantidou 1990, Diamandis 1992).

***Morchella conica*** Fr.
On gravel among *Q. coccifera* and *A. cephalonica*, April 1997, rather rare (Karveli); however, after a forest fire (summer 1998), it was recorded in large numbers in the *P. nigra* and *A. cephalonica* forests, May 1999 and 2000 (S3, S4). Common in Greece in a wide variety of habitats (Philippoussis & Balis 1995, Zervakis & al. 1999).

†***Otidea alutacea*** (Pers.) Massee
In *A. cephalonica*, gregarious, October (S4). Rather rare in Greece, reported only twice in the past (Diamandis 1992, Zervakis & al. 1999).

***Peziza violacea*** Pers.
On burned soil in great abundance after the forest fire of 1998, April-May (S3) (Zervakis & al. 1999). Apothecia: cup to disc shaped, up to 8 cm; hymenium dark violet to purple-brown; outer surface pale purple-gray, pruinose to minutely scurfy; sessile; flesh relatively thin and very fragile, whitish to gray-violet. Ascospores smooth, hyaline, often with 2 oily drops, 13-15 x 7-9 μm; asci 200-270 x 10-13 μm, operculum somewhat flat; paraphyses clavate, some are distinctly curved at their tips.

***Plicaria trachycarpa*** (Currey) Boud.
On burned ground in great abundance after the forest fire of 1998, April -May (S3) (Zervakis & al. 1999). Apothecia: cup to disc shaped up to 7 cm (when fully expanded), hymenium dark brown, olive-brown to almost black; outer surface scurfy, ochre-brownish to black; sessile, thick fleshed (2-3 mm); ascospores globose, hyaline to pale brown, finely warty; asci 180-240 x 10-15 μm; paraphyses slightly clavate, up to 6 μm at tips, with brown oily contents.

***Pithya vulgaris*** Fuckel
On fallen twigs of *A. cephalonica*, gregarious, February (S3, S4). Relatively common in Greece.

***Sarcosphaera coronaria*** (Jacq.) J. Schröt.
On chalky ground, in mixed forest under *A. cephalonica* solitary or in small clusters, rare collected only once in May 1999 (S2). Relatively common in Greece.

**Basidiomycotina**

†***Agaricus arvensis*** Schaef.
At the edges of *P. nigra* forest roads, collected only once in November 2000 (Artemisia-Piges). Few previous reports from Greece in fields.

****Agaricus macrocarpus*** (Moell.) Moell.
In *Pinus nigra* and *A. cephalonica* forests, solitary to gregarious, locally common, from September to early December 1999 (S4). Closely related to *A. abruptibulbus* Peck, but the cheilocystidia have papiliform tips (Breitenbach & Kränzlin 1995).

†***Agaricus pampeanus*** Speg.
In grassy meadows at the limits of a mixed forest, locally abundant and possibly widespread, October to early December (S2). Closely related to *A. campestris* but with distinctly larger spores and a more or less evident germ pore (Breitenbach & Kränzlin 1995, Cappelli 1984). Two other records in *Fagus* (Dimou & al. 2002), and in *Quercus* forests (Zervakis & al., submitted).

†***Agaricus silvicola*** (Vittad.) Peck
In *A. cephalonica* and in *P. nigra*, September-October, common (S3). This species has been previously reported by Maire from coniferous forests in the Mt. Taygetos (Maire & Politis 1940), and from other *A. cephalonica* forests in Peloponnese (Diamandis & Minter 1981).

†***Albatrellus pes-caprae*** (Pers.) Pouzar
In *P. nigra* and *A. cephalonica* forests, in clusters and large numbers, rather rare, October 1999 (Neochori-Perdikoneri). Only one previous report from Greece in *F. sylvatica* (Pantidou & Gonou 1984).

†***Albatrellus subrubescens*** (Murrill) Pouzar
On needle litter of *P. nigra* and *A. cephalonica* forests, in clusters, November (S4). Only one previous report from Greece in *Picea abies* (Diamandis 1992).

†***Amanita echinocephala*** (Vittad.) Quél.
In *P. nigra* and *A. cephalonica* forests, solitary, rare, October 1999 (S4). Reported from Greece only once before in *Quercus pubescens* (Diamandis & Perlerou 1990).

†***Amanita franchetii*** (Boud.) Fayod
In *P. nigra* and *A. cephalonica* forests, solitary, not common, September-early November 1999 (S4). This is the first record of the form with brown pilei; the other form with yellow pilei has been previously reported from *Fagus sylvatica* in Mt. Oxya (Dimou & al. 2002).

†***Amanita gemmata*** (Fr.) Gill.
In *P. nigra* and *A. cephalonica* forests, solitary, not common, May-June 1999 (S4; and in the Vasiliki forest at the western slopes of Mavrovouna, alt. 1100m). Grobing in spring, it has non-amyloid spores and a characteristic orange-yellow pileus with fugacious veil remnants and transient annulus. Only one previous report (Gonou-Zagou 2000).

†***Amanita mairei*** Foley
In mixed forest of *A. cephalonica* and *Q. coccifera* forests, solitary, rather rare, September 1999 (S2), and in *P. nigra* & *A. cephalonica*, solitary, uncommon, September to early November 1999 (S3, S4). Similar macroscopically to *A. vaginata* which however has globose to subglobose spores (as opposed to the broadly elliptical to ovoid spores of *A. mairei*). Only two other reports (Gonou-Zagou 2000; Zervakis & al., submitted).

***Amanita muscaria*** (L.) Hook **var. *muscaria***
In mixed forests of *A. cephalonica* and *P. nigra*, September-November, very common (especially in autumn of 1999, extremely abundant in the N-NW slopes around the village of Neochori) (S3, S4, S5). Very common throughout Greece in a large variety of habitats (Zervakis & al. 1998),

previously reported from Mt. Taygetos in *Pinus* sp. (Pantidou 1990).

***Amanita muscaria* . f. *aureola*** (Kalchbr.) J. E. Lange
In *P. nigra*, relatively rare, October 1998 (S3). This variety is characterized by an orange pileus lacking velar warts (Breitenbach & Kränzlin 1995).

† ***Amanita pantherina*** (DC.) Krombh.
In *P. nigra* forest, but growing close to a *Castanea sativa* tree, solitary, rare, September (S3). Common in Greece, reported from a large variety of habitats.

***Amanita rubescens*** (Pers.) Gray
In *P. nigra* and *A. cephalonica* forests, gregarious in rings, extremely abundant in 1999, from September to early November (S4, Nedousa), and in *C. sativa* and *A. cephalonica* forests at the end of November 2000 (Neochori). Common in Greece.

***Amanita vaginata*** (Bull.) Vittad.
In *Abies cephalonica* or in mixed forests of *Q. coccifera* and *A. cephalonica*, solitary, rather rare, October 1999 (S4, S2). Common in Greece.

****Amphinema byssoides*** (Pers.) J. Erikss.
On woody debris of *A. cephalonica*, and on bark of *P. nigra*, December 1999 (S2, S4). Basidiocarp resupinate, athelioid, loosely attached to the substrate, with light ochraceous yellow colour, and characteristic crater-like depressions in the hymenium.

****Amylocorticium cebennense*** (Bourd.) Pouzar
On log of *P. nigra*, December 1999 (S4). Basidiocarp effused, more or less athelioid, hymenium smooth, white when fresh, more light yellowish when dry, margin finely fibrillose; cystidia not present.

****Amylocorticium subsulphureum*** (P. Karst.) Pouzar
On dry cone of *P. nigra*, December 1999 (S4). Basidiocarp effused and adnate, soft, hymenium smooth and yellow, cystidia present. Common on Mediterranean coniferous woods.

***Antrodia sinuosa*** (Fr.) P. Karst.
On *A. cephalonica* wood, collected in May 1999 (Vasiliki forest, and western slopes of Mavrovouna, alt. 1,100 m). It causes a brown cubical rot. It is characterized by short allantoid spores, 4-6 x 1-2 μm, non amyloid skeletal hyphae and 1-3 pores per mm (Ryvarden & Gilbertson 1993). One previous record from the same substrate in Mt. Oxya (Dimou & al. 2001).

†***Astraeus hygrometricus*** (Pers.) Morg.
In mixed *A. cephalonica* and hardwood forest, solitary, November (S2); and in *P. nigra*, gregarious, among needles, May (31st km Kalamata–Sparti road). Common in Greece (Zervakis & al. 1998); however, the report in *P. nigra* constitutes a new mycorhizal host record.

****Athelia decipiens*** (Höhn. & Litsch.) J. Erikss.
On rotten wood of *P. nigra*, December 1999 (S4). Basidiocarp thin, white and pellicular.

****Athelia epiphylla*** Pers.
On rotten wood of *P. nigra* and *A. cephalonica*, resupinate, December (S4). Basidiocarp thin, white to light yellowish.

†***Boletus appendiculatus*** Schaeff.
In mixed *A. cephalonica*, *J. oxycedrus* and *Q. coccifera* forests, September-October, rare 1996 (S2). Previously reported from central and northern Greece, in various habitats (Pantidou 1980, Diamandis 1985, Diamandis 1992).

†***Boletus calopus*** Pers.
In mixed *A. cephalonica*, *J. oxycedrus* and *Q. coccifera* forests, relatively common, September-

October (S2), and in *P. nigra & A. cephalonica* (S4). Rather common in Greece, in a wide variety of habitats.

***Boletus edulis*** Bull.
In *P. nigra* and *A. cephalonica* forests, October (S4). Most of the collected basidiomata were growing relatively close to scattered *Castanea sativa* trees. Common in Greece.

***Boletus luridiformis*** Rostk.
In *P. nigra* and in *A. cephalonica* forests, common, solitary to gregarius, September-November (S2, S3, S4). Common throughout Greece, in coniferous woods, previously reported as *B. erythropus* (Fr.) Pers.

†***Boletus pinophilus*** Pilát & Dermek
In *P. nigra* and in *A. cephalonica* forests, solitary, September 1999 (S4), and June 2000 (Vasiliki forest). Only two previous records from Greece in *Pinus* spp. (Keltemlidis 1990, Diamandis 1992).

****Boletus splendidus*** Martin **ssp.** ***moseri*** Singer & Kuthan
In *A. cephalonica* and *Q. coccifera* forests, rather rare, September-October 1996 (S2). Pilei with mouse grey colour, tomentose, epicutis with thinner end hyphae than in *B. splendidus* ssp. *splendidus* (Moser 1983); stipe with fine net markings and with purple-red pores from early stages.

****Botryobasidium botryosum*** (Bres.) J. Erikss.
On rotten wood of *P. nigra*, December 1999 (S4). Basidioma thin, hypochnoid, greyish white to yellowish; hyphae without clamps.

****Botryobasidium subcoronatum*** (Höhn. & Litsch.) Donk
On wood and wood debris of *A. cephalonica*, resupinate, December (S2, S4). Basidioma thin, hypochnoid, first whitish then yellowish or ochraceous; hyphae with clamps at all septa; conidial state not present.

†***Bovistella radicata*** (Dur. & Mont.) Pat.
In mixed forests of *P. nigra* and *A. cephalonica*, common, solitary or in small groups, September-November (S2, S3, S4). Previously recorded only twice in Greece: from Kastanea (Trikala) in *Abies* sp. (Minter 1988), and in Mt. Taygetos (Pantidou 1973).

****Calocera furcata*** (Fr.) Fr.
On *A. cephalonica* logs, September-November, common (S2, S3, S4). This is the first record for Greece, found every year in the course of this study.

***Calocera viscosa*** (Pers.) Fr.
On rotten wood of *P. nigra* and of *A. cephalonica*, very common, October-December (S2, S3, S4, S5). Very common in Greece on conifer wood.

****Camarophyllus pratensis*** (Pers.) P. Karst.
On wet grassy-mossy soil, at the edges of *P. nigra* and *A. cephalonica* forest, solitary, rare, only one basidioma collected, end of September 1999 (S3). This member of the subgenus *Cuphophyllus* is characterized by yellow-orange to orange-brown pileus, thick intervenose isabella to pale orange lamellae and spores measuring 5.5-8.0 x 4-6 μm containing one large oily drop.

***Camarophyllus virgineus*** (Wulf.) P. Kummer
On damp grassy soil in *P. nigra* forest, solitary to gregarious, October (S3). According to Hansen & Knudsen (1992), the names *Hygrophorus niveus*, *Hygrocybe nivea* and *Hygrocybe virginea* var. *virginea* are considered synonyms. Three other reports from Greece, the first two as *Hygrophorus niveus* Fr. (Maire & Politis 1940, Diamandis 1992; Zervakis & al., submitted).

†***Cantharellus cibarius*** Fr.
In *P. nigra* and *A. cephalonica* forests, solitary or in clusters, rather common, October-December (S4). Scattered trees of *Castanea sativa* exist in the coniferous forest, and most of the collected basidiomata were found relatively close to those trees. Common in Greece, reported from various habitats (Zervakis & al. 1998); this report constitutes the first host record for *P. nigra* in Greece.

†***Chalciporus piperatus*** (Bull.) Bat.
In *P. nigra* forest, rare, October 1999 (S3). Relatively rare in Greece.

***Chroogomphus rutilus*** (Schaeff.) O.K. Miller
In mixed forests of *P. nigra* and *A. cephalonica*, very common, September-November (S3, S4). Common in Greece, in coniferous habitats.

†***Clavaria acuta*** Sowerby
In *A. cephalonica*, common, September-November (S3, S4). Rare in Greece, only one report in the past from Mt. Olympos among ferns (Diamandis & Perlerou 1990).

***Clavariadelphus truncatus*** (Quél.) Donk
In mixed forests of *P. nigra* and *A. cephalonica*, rather common, October-November (S3, S4). Relatively common in fir forests of southern and central Greece.

†***Clavulina cinerea*** (Fr.) J. Schröt.
In *P. nigra* and *A. cephalonica* forests, solitary, September-December 1999 (S3). Only one report from Greece in the past from mixed forests of broadleaved and coniferous trees (Diamandis 1992).

†***Clavulina coralloides*** (L.) J. Schröt.
In *P. nigra* and *A. cephalonica* forests, gregarious in rows, October 2000 (S3, S4). Few previous reports as *C. cristata* (Fr.) Schröt. and as *Clavaria cristata* (Fr.) Pers., but probably not rare in Greece (Zervakis & al. 1998).

***Clavulina rugosa*** (Bull.) Schröt.
In *P. nigra* among needles, common, October-November (S3). Common in Greece in coniferous habitats (Zervakis & al. 1998).

****Clitocybe diatreta*** (Fr.) P. Kummer
In *A. cephalonica* on mossy stands, relatively rare, November-December 1996 and 1998 (S2). This taxon is characterized by beige spore-prints, flesh-brownish pilei with darker center, weakly striate margins, light beige lamellae and spores measuring 4.2-5.8 x 3.1-3.7 µm.

***Clitocybe geotropa*** (Bull.) Quél.
In *A. cephalonica* forest on mossy stands, October-December, relatively common (S2). Common in Greece.

***Clitocybe gibba*** (Pers.) P. Kummer
In mixed forests of *A. cephalonica* and *P. nigra*, September-November, relatively common (S3). A common species recorded in a variety of habitats in Greece.

***Clitocybe odora*** (Bull.) P. Kummer
In *A. cephalonica* forest on mossy stands, September-November, very common (S2, S3, S4). Very common throughout Greece, mainly in coniferous woods.

†***Clitocybe sinopica*** (Fr.) P. Kummer
In mixed forests of *A. cephalonica* and *J. oxycedrus* intermixed with *Q. coccifera*, September-October, common (S2). Rare in Greece, only one previous report from *Quercus macrolepis* forest (Maire & Politis 1940).

***Clitopilus prunulus*** (Scop.) P. Kummer
In *P. nigra* and *A. cephalonica* forests (S4), or in mixed forest (S2), solitary or in small clusters, relatively common, September-early November. Recorded twice before in Greece from coniferous forests (Pantidou 1980, Pantidou 1990).

†***Coltricia perennis*** (L.) Murrill
In mixed *A. cephalonica* and *Q. coccifera* forests, concrescent, rare, collected only in November 2000 (S2). Rather rare in Greece, previously recorded from various authors in *F. sylvatica* and *P. halepensis* (Zervakis & al. 1998), and in *A. cephalonica* forest (Dimou & al., unpublished results).

****Columnocystis abietina*** (Fr.) Pouzar
On *A. cephalonica* logs, relatively rare, January 1997 (S2). Basidiocarp perennial, pileate or resupinate, with brown zonate tomentum and light brown margin and dark violaceus hymenium. It is a boreal widespread species, rather common in the spruce forest area of northern Europe.

†***Coniophora arida*** (Fr.) P. Karst.
On dead wood of *A. cephalonica*, resupinate, December 1999 (S4). It is closely related to the *C. puteana*, which however, differs by having a smooth, thicker basidioma, and weakly dextrinoid spores. Recorded previously on *C. sativa* and *Pinus* spp. (Minter 1988), and on *F. sylvatica* (Dimou & al. 2002).

****Coniophora olivacea*** (Pers.) P. Karst.
On stump of *P. nigra*, December 1999 (S4). It differs from other member of the genus by having thick-walled, septate cystidia. Some authors place this species in the genus *Coniophorella* on the basis of the presence of cystidia. This is a common and widespread European species generally found on coniferous wood, but it has also been reported from deciduous hosts.

****Conocybe blattaria*** (Fr.) Kühner ss. K.v.Wav.
On damp soil in *P. nigra* and *A. cephalonica* forests, in small groups, collected once in May 2001 (S3). Our specimens had membranous annulus with strongly striate upper surface, 4-spored basidia, cheilocystidia lageniform with long flexuous neck, and spores (9)10-14 x 5.8-7.5(8) μm. Their characteristics fit the description of Breitenbach & Kränzlin (1995) and Hansen & Knudsen (1992; classified as *C. vexans* Orton), with the exception of spore width that is reported to be 5.4-6.5 μm.

†***Conocybe semiglobata*** (Kühner) Kühner & Watl.
In *A. cephalonica* forest, relatively common, September-October 1996 and 1997 (S2). One previous report from the alpine zone of Mt. Oxya (Dimou & al. 2002).

****Coprinus angulatus*** Peck
In burned *P. nigra* forest, May 2000 (31st km of the Kalamata – Sparti road). This taxon is classified in section *Pseudocoprinus* subsect. *Setulosi*, because of the absence of a true veil and the existence of lageniform pileocystidia (setulae). It is the only taxon of this subsection that presents distinctly mitriform spores and grows on burned soil.

***Coprinus comatus*** (Müll.) Pers.
In forest clearings, in *P. nigra* and *A. cephalonica* forests, in huge colonies but locally not widespread, October (S3, S4). Common in Greece.

†***Cortinarius cinnamomeus*** (L.) Fr.
In mixed forests of *A. cephalonica* and *P. nigra*, September-October 1996 and 1999, relatively rare (S3). Reported from Greece only once before in *Quercus conferta* (Diamandis & Perlerou 1994).

****Cortinarius claricolor* var. *immissus*** Schlapfer (syn. *C. subaffinis* R. Hry.)
In *P. nigra* and *A. cephalonica* forests, gregarious, in small clusters, relatively common, October

- early November (S4). This taxon is characterized by the orange-foxy pileus, the pale lilac to grey violet colour of the young lamellae, and the basidiospores measuring 6.8-10.1 x 4.0-5.6 µm (sensu Moser 1983).

***Cortinarius croceus*** (Schaeff.) Bigeard & Guillemin
In mixed forests of *A. cephalonica* and *P. nigra*, collected only once in October 1999 (S3). A member of subgenus *Dermocybe* with bright yellow stipe and cortina, yellow to olive-yellow young lamellae, and basidiospores 6.5-9.0 x 4.3-5.5 µm.

***Cortinarius dibaphus*** Fr.
In *A. cephalonica* (S4) or in a mixed forest (S2), solitary, relatively common and widespread, October-November. Reported from Greece only from *A. cephalonica* (Pantidou 1973, Pantidou 1980).

***Cortinarius evernius** (Fr.) Fr. **var. *fragrans*** m.m. Moser
In *P. nigra* and *A. cephalonica* forests, in small clusters, collected once in October 1999 (S3). It differs from var. *evernius* in the conspicuous radish smell of flesh (Moser 1983, Hansen & Knudsen 1992).

***Cortinarius lividoochraceus*** (Berk) Berk
In *P. nigra* and *A. cephalonica* forests, gregarious, in small clusters, relatively common, October to mid-December (S4). Reported from Greece only once before in *P. nigra* as *C. elatior* Fr. (Athanasiou & Theochari 1999).

***Cortinarius infractus*** (Pers.) Fr.
In *A. cephalonica* (S4) or in a mixed forest (S2), solitary or in small clusters, relatively common and widespread, October-December. Reported in Greece only from Mt. Taygetos (Maire & Politis 1940; Zervakis & al., submitted).

***Cortinarius odorifer** Britz.
In *A. cephalonica* (S4) or in a mixed forest (S2), solitary, relatively common and widespread, October-November. This taxon is classified in the subgenus *Phlegmacium* section *Fulvi*, and presents yellow-greenish lamellae and a distinct macrochemical reaction of the flesh which turns blood-red with KOH. Specimens have a strong anise odor.

***Cortinarius orellanus** (Fr.) Fr.
In mixed forests of *A. cephalonica* and *P. nigra*, rare, October 1996 and 1997 (S3). This species belongs to the subspecies *Leprocybe* section *Orellani* (Moser 1983), and is characterized by broadly elliptical spores measuring 8.8-11.6 x 5.6-7.2 µm, yellow-brown to orange red-brown pilei with fine adpressed fibrils, thick and distant cinammon to brown lamellae, and a radish-like smell.

***Cortinarius subannulatus** J. Schaeff. & M.M. Moser
In mixed forests of *A. cephalonica* and *P. nigra*, relatively rare, in October 1996 and 1998 (S3). It belongs to *C. subannulatus* subsp. *Leprocybe*, section *Leprocybe* (Moser 1983), and is characterized by a yellow-greenish veil forming a distinct ring which at maturity becomes dark brown, pilei with the same colours and spores measuring 6.3-8.8 x 5.2-6.7 µm.

***Cortinarius variecolor** (Pers.) Fr.
In *P. nigra* and *A. cephalonica* forests, solitary, rare, October (S4). Our specimens characteristics coincide with the macroscopic description of Moser (1983), but spores are larger: 10-13(14) x 5.7-7.0 µm.

***Crucibulum laeve*** (Huds.) Kambly
On rotten wood of *A. cephalonica*, rare but possibly overlooked, October-November (S2, S4). Rather common in Greece.

***Cystoderma amianthinum*** (Scop.) Konrad & Maubl.
On moss close to *A. cephalonica* trees, solitary, locally relatively rare, December (S4). Common in Greece, in coniferous forests.

***Cystoderma carcharias*** (Pers.) Konrad & Maubl.
In *P. nigra* and *A. cephalonica* forests in mossy stands, relatively common, November-December (S2, S3, S4). Relatively common in Greece mainly in *A. cephalonica* forests.

***Cystoderma granulosum*** (Batsch.) Kühner
In *P. nigra*, common, October-November (S2). Common throughout Greece in coniferous forests.

***Cystoderma terrei*** (Berk & Broome) Harmaja
In *P. nigra* and *A. cephalonica* among ferns, relatively common, October-December (S3, S4). Relatively common in Greece in coniferous forests.

****Dacrymyces confluens*** P. Karst.
On dead wood of *P. nigra*, collected once in April 2000 in dried condition (S4). Collected specimens have 1-3 septate basidiospores (15-21 x 5-6.5 μm) and clamp-connections on most septa (Jülich 1984).

***Dacrymyces stillatus*** Nees
On *A. cephalonica* logs, relatively rare, September-October (S2). Recorded on a wide variety of substrates (Maire & Politis 1940, Diamandis & Minter 1981, Diamandis 1992); the first report was under the name *Dacryomyces deliquescens*.

† ***Dacryobolus karstenii*** (Bres.) Oberw. ex Parmasto
On rotten branches of *P. nigra*, December 1999 (Artemisia). Only one previous record in Greece on *Pinus* sp. and *Abies* sp. (Minter 1988). Basidioma resupinate with smooth hymenium and thick-walled cystidia strongly swollen in KOH which differs from *D. sudans*; when fresh the fungus has a pleasant odour.

†***Dacryobolus sudans*** (Alb. & Schwein.) Fr.
On rotten wood of *P. nigra*, resupinate, February (S3). Only one previous record in Greece on *Quercus frainetto* (Minter 1988).

†***Entoloma hirtipes*** (Schum.) M.M. Moser
In *P. nigra* forest, relatively rare, October 1996 and 1998 (S3). Rather common in Greece.

†***Entoloma incanum*** (Fr.) Hesler
On mosses in grassy edge of *P. nigra* forest, April 2000 (Mavra Litharia). Reported only once before in Greece from fields (Pantidou 1990).

****Entoloma serrulatum*** (Fr.) Hesler
In mixed *A. cephalonica* and *Q. coccifera* forests, solitary, end of November 1999 (S2). This species is characterized by the dark blue-violet crenulate lamellae edges.

†***Exidia pithya*** (Alb. & Schwein.) Fr.
On dead branch of *A. cephalonica*, common, August–December (S2), and in June (Exochori). Reported only once in the past (Diamandis & Perlerou 1990), but possibly overlooked.

†***Exidia umbrinella*** Bres.
On dry branches of *P. nigra*, solitary to gregarious, December 1999 (S4). When young the hymenium is yellowish brown and then dark brown. One previous report from Aroania Mts. (Delivorias & Gonou-Zagou 2000).

****Faerberia carbonaria*** (Alb. & Schw.) Pouzar
In burned *Pinus nigra* forest, October (Mavra Litharia). Another common inhabitant of burned places. Although lamellate, the basidiomata are characterized by a dimitic hyphal system, and

hence the fungus is classified in Lentinaceae. Lamellae are poorly developed and strongly veined. Typical microscopic features are the dextrinoid metuloids with incrusted apex as well as the shape and size of cheilo- and pleurocystidia.

***Fayodia maura** (Fr.) Singer
On soil in burned *P. nigra* forest, gregarious, end of September 1999 (S3). Typical inhabitant of burned places, which is characterized by umbilicate dark brown pilei with striate margins and thick-walled amyloid spores.

†***Fomitopsis pinicola*** (Sw.) P. Karst.
On wood of *P. nigra* and on *A. cephalonica*, common, all year (S3, S4). Despite its relatively wide distribution in Greece, this is the first report of *P. nigra* as a host-species (Zervakis & al. 1998).

***Galerina marginata*** (Batsch.) Kühner
On rotten trunk of *A. cephalonica*, in clusters or solitary rather common, September-December (S2, S3, S4). Relatively common in Greece, mainly in coniferous forests.

****Galerina praticola*** (Müller) P.D. Orton
Among mosses, in mixed *A. cephalonica* and *Q. coccifera* stands, gregarious, November-December (S2). The characteristics of our specimens fit the description of *G. praticola*, and should be classified into this taxon and not in *G. unicolor* (Watling & al. 1993); spores size is 10.3-13.0 x 5.2-6.8 μm, the cystidia are slender and fusiform (40-85 x 8-15 μm).

***Galerina unicolor*** (Vahl ex Sommerf.) Singer
On dead branches of *A. cephalonica*, common, September-October (S3). Two previous records from southern Greece in coniferous woods (Pantidou 1973, Pantidou 1980).

****Galerina vittiformis*** (Fr.) Singer
On moss or on bare soil, in burned *P. nigra* and *A. cephalonica* forest, solitary, end of September 1999 (S3). It is characterized by two-spored basidia, spores size 10.0-14.5 x 6-7 μm, pileocystidia absent, cheilocystidia subcapitate to lageniform (40-65 x 10-16 μm). Our measurements fit the description of two-spored forms of this taxon by Watling & al. (1993); in Hansen & Knudsen (1992), it is referred to as *G. vittiformis* var. *pachyspora*, but with broader spores 6.0-9.5 μm.

***Ganoderma carnosum*** Pat.
On *A. cephalonica*, rare, December 2000 (S4). Relatively common on conifers in Greece.

****Geastrum elegans*** Vittad.
In *P. nigra* and *A. cephalonica* forests, in small group, rare, only one collection, November 1999 (S4). This is one of the smallest taxa of the genus with endoperidial body up to 1 cm in diam., sessile with plicate peristome, which is not however limited by a circular ridge as it is the case in the similar taxon *G. schmidelii*, in addition, the latter has a short-stipitate endoperidial body (Pegler & al. 1995).

****Geastrum berkeleyi*** Massee
In mixed forests of *P. nigra* and *A. cephalonica*, on wood debris, gregarious, relatively rare, September-December, collected once in 1997 and twice in 1999 (S4). Endoperidial body up to 4 cm in diam with conspicuously verrucose surface and plicate peristome, exoperidium not hygroscopic. Very rare and possibly extinct in Britain, recorded in Europe only from Denmark and Sweden (Pegler & al. 1995).

***Geastrum rufescens*** Pers.
In mixed forests of *P. nigra* and *A. cephalonica*, October, rare, solitary (S4). Rare in Greece, reported only twice in the past from coniferous woods (Diamandis & Minter 1981, Diamandis 1992).

†***Geastrum sessile*** (Sowerby) Pouzar
In mixed *A. cephalonica* and *Q. coccifera* forests, gregarious, November-December (S2). Previously reported as *G. fimbriatum* Fr. in various forests (Zervakis & al. 1998).

***Geastrum triplex*** Jungh.
In *P. nigra* and *A. cephalonica* forests (S4), or in mixed forests (S2), gregarious, November-December. Common in Greece.

†***Gloeophyllum abietinum*** (Bull.) P. Karst.
On *A. cephalonica* dead branches and stumps, common, September-October (S4). Rather common in Greece.

***Gloeophyllum sepiarium*** (Wulf.) P. Karst.
On *A. cephalonica* dead branches and stumps, common, October-December (S3, S4). Common throughout Greece.

***Gomphidius glutinosus*** (Schaeff.) Fr.
In forest of *P. nigra*, relatively common, October-November (S3, S4). Common in Greece in coniferous habitats.

†***Gomphus clavatus*** (Pers.) Gray
In forest of *P. nigra*, relatively rare, October 1999 (S3) and in *P. nigra* & *A. cephalonica* forests, 1999 (Neochori - Perdikoneri). Only two previous reports in the past from *A. cephalonica* forests in the southern part of Greece (Pantidou 1980, Diamandis & Minter 1981).

****Gymnopilus bellulus*** (Peck) Murrill
On rotten trunk of *A. cephalonica*, in clusters, October 1999 and September 2000 (S3, S4). The small size of basidiomata (up to 2.5 cm in diam) and spores (4.0-5.5 x 2.8-3-5 µm), the typical lageniform cheilocystidia with long slender neck and the conifer wood habitat are the basic diagnostic features of this taxon (Watling & al. 1993).

***Gymnopilus penetrans*** (Fr.) Murrill
On *A. cephalonica* and on *P. nigra* stumps and plant residues, common, growing in clusters with numerous basidiomata, September-October (S3, S4). Very common throughout Greece in coniferous woods.

****Gymnopilus stabilis*** (Weinm.) Kühner & Romagn.
On twigs or buried conifer wood, solitary or in clusters, September 1999 (S4). Pileus surface slightly adpressed and fibrillose, context hard, odour strong fruity, bitter taste, cystidia lageniform (20-50 x 6-10 µm), spores 6.5-8.5 x 3.8-5.0 µm (Watling & al. 1993).

****Hebeloma circinans*** Quél.
In *P. nigra* and *A. cephalonica* and mixed forests, solitary to small groups, October–December 1999 (S2, S4). Pileus viscid 4-6 cm, spores verrucose (8)8.5-11.5 x 5.0-6.3 µm, cheilocystidia ventricose-capitate or vermiform, with a sweet cocoa smell and a radish-like (not bitter) taste.

†***Hebeloma sinapizans*** (Paulet) Gill.
In *A. cephalonica*, common, September-October (S3). Relatively common in Greece on both hardwoods and conifers, but not in *Abies* spp (Zervakis & al. 1998).

***Hemimycena lactea*** (Pers.) Singer
On needles of *A. cephalonica*, uncommon, December 2000 (S2). Common in Greece in conifer forests, previously reported as *Mycena lactea* (Zervakis & al. 1998).

***Heterobasidion annosum*** (Fr.) Bref.
On dead trunks of *A. cephalonica*, November (S4) and of *P. nigra*, June (Vasiliki forest), solitary, imbricate, rather common. Widespread in Greece, it causes significant damages in fir forests and has been reported in the past to attack conifers in the area under study (Tsopelas &

Korhonen 1996).

***Hohenbuehelia geogenia*** Singer
On mossy soil/remains of wood in *A. cephalonica* mixed forest, October-November (S2). Rather common in Greece with a marked preference to coniferous habitats.

†***Hydnellum caeruleum*** (Horn.) P. Karst.
In *P. nigra* and *A. cephalonica* forests, solitary, rare, October 1999 (Neochori–Perdikoneri). Only one previous record in Greece from *A. cephalonica* (Pantidou 1980).

†***Hydnellum ferrugineum*** (Fr.) P. Karst.
In *P. nigra* and *A. cephalonica* forests, solitary, rare, October 1999 (Neochori–Perdikoneri, S4). Only one previous record in Greece from *A. cephalonica* (Diamandis 1992).

†***Hydnellum peckii*** Banker
In *P. nigra* and *A. cephalonica* forests, solitary, rare, October 1999 (Neochori–Perdikoneri). Only one previous record from Greece in *A. cephalonica* (Diamandis & Minter 1983).

***Hydnum repandum*** L.
In *P. nigra* and *A. cephalonica* forests, solitary, rather rare, October 1999 (S3). Common in Greece.

****Hygrocybe conica*** . **var.** ***chloroides*** Malençon
On mossy wet soil under *Q. coccifera*, in mixed forest, December 2000 (S2). It differs from *H. conica* var. *conica* mainly by the colour of pileus and stipe, where yellow-green colours dominate and red or orange are lacking or appear occasionaly on pileus only. In addition, the spores of the collected specimens were slightly broader and all basidia were 4-spored (Bas & al. 1990).

***Hygrophorus chrysodon*** (Batsch) Fr.
In *P. nigra* and *A. cephalonica* forests (S4), or in mixed forest (S2), solitary to gregarius, common, October to mid-December. Common in Greece.

***Hygrophorus hypothejus*** (Fr.) Fr.
In *P. nigra* and *A. cephalonica* forests, gregarious in clusters, end of November after the first frost (S3). Relatively common in Greece in coniferous habitats.

†***Hygrophorus olivaceoalbus*** (Fr.) Fr.
In *P. nigra* and *A. cephalonica* forests, relatively rare, October 1999 (S3). Previously collected only in Attiki from *A. cephalonica* and *P. halepensis* forests (Pantidou 1973, Pantidou 1980, Pantidou 1990).

***Hygrophorus pudorinus*** (Fr.) Fr.
In *P. nigra* and *A. cephalonica* forests, solitary, relatively common, October-December (S2, S4). Relatively common in Greece in coniferous habitats.

* ***Hyphodontia breviseta*** (P. Karst.) J. Erikss.
On rotting branches of *P. nigra*, December 1999 (S4). Basidiocarp resupinate, effuse, adnate, thin, first white or whitish, then pale yellowish. Hymenium is irregularly odontoid with conical aculei.

†***Hyphodontia crustosa*** (Pers.) J. Erikss.
On rotten wood of *A. cephalonica*, March 2000 (S2). Only one previous record from Greece in Mt. Olympos on *Abies* sp. (Minter 1988).

* ***Hyphodontia subalutacea*** (P. Karst.) J. Erikss.
Dry branches of *P. nigra*, December 1999 (S4, Artemisia). Basidiocarp smooth to finely tuberculate.

***Hypholoma fasciculare*** (Hudson) P. Kummer
On dead stumps of *P. nigra*, October (S4). Common in Greece on a large variety of hosts.

†***Inocybe bongardii*** (Weinm.) Quél.
In mixed forests of *A. cephalonica* and *J. oxycedrus*, common, September-October (S2). Reported only twice in the past from *A. cephalonica* forests (Maire & Politis 1940, Pantidou 1980).

***Inocybe geophylla* var. *lilacina*** (Peck) Gill.
Among sphagnum in *P. nigra* and *A. cephalonica* forests, gregarious in large numbers, October (S4), and in mixed forests until December (S2). Common in Greece in various habitats (Zervakis & al. 1998).

†***Inocybe perlata*** (Cooke) Sacc.
In mixed forest of *A. cephalonica* and *Q. coccifera*, under *A. cephalonica*, gregarious, rather uncommon, September 1999 (S2). One previous record in *Q. conferta* (Diamandis 1992).

***Ischnoderma benzoinum*** (Wahl.) P. Karst.
On dead wood of *A. cephalonica*, solitary or imbricate, September-November (S4). Rather common in central and northern Greece.

†***Laccaria amethystina*** Cooke
In *P. nigra* forest, relatively rare, October-November 1996 (S5). Not common in Greece, but reported from a variety of habitats (Zervakis & al. 1998).

***Laccaria laccata*** (Scop.) Berk & Broome
In mixed forests of *A. cephalonica* and *P. nigra*, relatively common, September-October (S3, S4). Very common in Greece in a large variety of habitats.

***Lactarius deliciosus*** (L.) Gray
In forest of *P. nigra*, common, September-November (S3, S4, S5). Very common throughout Greece.

***Lactarius scrobiculatus*** (Scop.) Fr.
In *P. nigra* and *A. cephalonica* forests, common, solitary or in small clusters, September–December (S3, S4). Rather common in Greece in conifer forests.

†***Lactarius semisanguifluus*** Heim & Lecl.
In *P. nigra* (S3), and in *P. nigra* and *A. cephalonica* forests (S4) , common, September-December. Recorded twice in the past in *Abies* forests as *L. deterrimus* (Diamandis & Minter 1981, Diamandis 1992).

***Lentinellus castoreus*** (Fr.) Konrad & Maubl.
On dead conifer wood (*Pinus* or *Abies*), solitary to imbricate, common, November 1999 (S4, Nedussa), and on *A. cephalonica*, imbricate, February 2000 (S2). This species has been previously reported as *L. ursinus* on *Abies* spp. wood (Zervakis & al. 1998).

†***Lentinellus flabelliformis*** (Bolt.) Ito
On rotten wood of *A. cephalonica*, locally common, October-November (S4). Only two previous records from Greece on *F. sylvatica* (Pantidou & Gonou 1984, Dimou & al. 2002).

†***Lepiota clypeolaria*** (Bull.) P. Kummer
In forest of *P. nigra*. October-December, common (S5), and in mixed forests of *A. cephalonica* and various hardwoods until December (S2). Relatively common in Greece, mainly in fir forests.

***Lepiota cristata*** (Bolt.) P. Kummer
On *P. nigra* needles, at roadsides, gregarious, not very common, but widespread, September-October (S3, Nedousa). Relatively common in Greece in a large variety of forest types.

†***Lepista flaccida*** (Sowerby) Pat.
On needle litter in *P. nigra* and *A. cephalonica* forests and in mixed forests, gregarious, November-December (S4, S2). Rather rare in Greece, previously reported as *Clitocybe flaccida* and as *Lepista inversa*.

†***Lepista gilva*** (Pers.) Pat.
In mixed forests of *A. cephalonica* and *P. nigra*, relatively rare, October 1996 (S3). Reported only twice in the past from Greece (Maire & Politis 1940, Pantidou & Gonou 1984).

****Lepista irina*** (Fr.) Bigel.
In grassy meadows in *P. nigra* and *A. cephalonica* forests, solitary to gregarious, rare, end of November 1999 (S3). The collected specimens produced ochre to cream spore-prints and had a pleasant odor, which are discriminating characters from the similar-looking taxon *L. glaucocana* (Bres.) Singer (Breitenbach & Kränzlin 1991).

†***Lepista luscina*** (Fr.) Singer
In mixed *A. cephalonica* and and hardwoods stands, in groups, February 2000 (S2). Only one previous record from *Pinus brutia* (Diamandis & Perlerou 1990).

****Leucoagaricus subcretaceus*** (Bon & van Haluwyn) Bon
Solitary in *P. nigra* forest, rare, collected only once in September 1999 (S3). The collected specimen have typically dextrinoid thick-walled spores with strongly metachromatic germ-pores. Macroscopically this taxon is characterized by the medium sized basidiomata (up to 8 cm in diam.) that resemble *Agaricus* spp., with ochraceus, finely areolate pilei, trapezoidal to hemisphaerical when young (Breitenbach & Kränzlin 1995).

***Limacella illinita*** (Fr.) Murrill
In *P. nigra* forest, solitary, rare, September 1999 (S4). Reported from Greece twice before in *P. nigra* from Mt. Taygetos (Maire & Politis 1940) and in *A. cephalonica* (Pantidou 1990).

****Litschauerella clematitis*** (Bourd. & Galz.) J. Erikss. & Ryvarden
On rotten branch of *A. cephalonica*, December 1999 (S4). Basidiocarp resupinate, effused, smooth, thin, whitish or pale cream-coloured when dried, pilose from the projecting cystidia.

†***Lycoperdon nigrescens*** (Pers.) Pers.
In mixed forests of *P. nigra* and *A. cephalonica*, common, September-November (S2, S3, S4). Only one previous report from central Greece (Minter 1988).

***Lycoperdon perlatum*** Pers.: Pers.
In mixed forests of *A. cephalonica* and *P. nigra*, very common, September-October (S2, S3, S4). Very common in Greece, recorded in a wide variety of habitats.

***Lycoperdon pyriforme*** Schaeff.:
On *P. nigra*, relatively rare, September-October (S3). Common in Greece, although this is the first record from the southern part of the country.

****Lyophyllum fumosum*** (Pers.) P.D. Orton
On humus and wood residues in *A. cephalonica* forest, September-October 1999 (S4). The connate habit, the dark gray-brown to gray-hazel pilei, the farinaceus smell and the slightly bitter taste are the main diagnostic features of this taxon. The subglobose spores (5-6 x 4.5-5.5 μm) and the structure of pileipellis consisting of generative hyphae (4-15 μm in diam.) with a brownish pigmentation are additional useful characters (Hansen & Knudsen 1992).

***Lyophyllum deliberatum*** (Britz.) Kreisel
On mossy soil in mixed forest, December 1999 (S2). Rather rare in Greece, reported from coniferous forests as *L. infumatum*.

***Lyophyllum sphaerosporum*** Kühner & Romagn.
On burned/rotten wood of *P. nigra*, solitary, October 1999 (S3). It has ornamented spores (callotes), and is hence distinguished from *L. anthracophilum* (otherwise identical macroscopically and ecologically) (Breitenbach & Kränzlin 1991).

***Lyophyllum transforme*** (Britz.) Singer
In *P. nigra* and *A. cephalonica* forests, in clusters, October-November 1999 (S4). The tetraedric or markedly triangular spores (syn. *L. trigonosporum* (Bres.) Kühner), and the lamellae discolouration to blue-gray and then blackish (when bruised) are typical features of this taxon. Previously recorded in Mt. Oxya in *A. cephalonica* (Dimou & al., unpublished results).

***Macrolepiota procera*** (Scop.) Singer
In *A. cephalonica* forest, common, September-October (S3, S4). Very common throughout Greece in a large variety of habitats.

†***Marasmius androsaceus*** (L.) Fr.
In mossy habitats rich in organic matter, on cones, and needle litter of *P. nigra* and *A. cephalonica*, common, gregarious, abundant, September-October (S2, S3, S4). Common for Greece, although rather scarcely reported in the past.

***Marasmius rotula*** (Scop.) Fr.
In mossy habitats rich in organic matter, rather common, September-October (S2). Common in Greece.

†***Marasmius scorodonius*** (Fr.) Fr.
In mixed forest under *A. cephalonica*, gregarious, September 1999 (S2). Only two previous records from *Fagus* forests in Mt. Pilion (Maire & Politis 1940, Pantidou & Gonou 1984).

†***Melanoleuca brevipes*** (Bull.) Pat. ss. Konrad & Maubl.
On grassy soil in meadows in mixed *A. cephalonica* and *Q. coccifera* forests, gregarious, December 2000 (S2). Only two previous reports from Greece (Gonou-Zagou & Delivorias 2000, Dimou & al. 2002).

†***Melanoleuca cognata*** (Fr.) Konrad & Maubl. **var. *cognata*** Kühn. ss. Konrad & Maubl.
In *P. nigra* and *A. cephalonica* forests, rather rare, collected only once at the end of May 1999 (S4). One record of *Melanoleuca cognata* from Evvoia in *A. cephalonica* (Pantidou 1990), which according to the habitat should belong to var. *typica*; and another record from Gardiki (Fthiotida) in the same host (Dimou & al., unpublished data).

****Mycena cyanipes*** Godey
On buried wood, cones, and needle litter of conifers, gregarious, September 1999 (S4). It differs from the similar-looking taxon *M. cyanorrhiza* Quél. (that has appendiculate cheilocystidia and lamellae edges with detachable gelatinous thread) by the smooth cylindric to ventricose cystidia and the simply cilliate lamellae edges (Moser 1983).

***Mycena epipterygia*** (Scop.) Gray **var. *epipterygia***
In mixed forests of *A. cephalonica* and *P. nigra*, common, October-November (S3, S4). Common in Greece, mainly in coniferous woods.

****Mycena epipterygia*** **var. *viscosa*** (Maire) Ricken
On wood or woody remains of *P. nigra* and *A. cephalonica*, in clusters, or if growing on buried wood, gregarious, November-December 1999 (S3, S4). Our specimens have dark brown pilei, lamellae edges peelable as threads and spotted brown in maturity, stipe yellow-green at early stages then turning reddish brown. Spores 7-11 x 5-8 μm and basidia are always four-spored (Hansen & Knudsen 1992).

***Mycena erubescens*** Höhn.

On dead wood of *A. cephalonica*, in clusters, November-December (S2). Only two other records from Mt. Parnitha on the same host (Pantidou 1980), and from Mt. Taygetos on *Q. frainetto* (Zervakis & al., submitted).

****Mycena flavoalba*** (Fr.) Quél.

On *P. nigra* needles, gregarious or in small clusters, end of September 1999 (S4). The yellowish pilei, the inamyloid spores (5.5-8 x 3-4 μm), the smooth fusiform to ventricose cheilo- and pleurocystidia (some of them surrounded by a rounded cap of amorphous material at the apex) are the main diagnostic characters of this species (Breitenbach & Kränzlin 1991).

****Mycena leptocephala*** (Pers.) Gill.

On soil, moss needles and pieces of wood, in *P. nigra* and *A. cephalonica* forests (S4), or in mixed forest (S2), solitary to gregarious, common, September-November. The main macroscopical difference from the similar looking *M. stipata* Maas G. & Schwöbel is the substrate and mode of growth; the latter is growing mainly on stumps or trunks and in clusters.

***Mycena pura*** (Pers.) P. Kummer

In mixed forests of *A. cephalonica* and *P. nigra*, October-November (S3, S4), also in mixed *Abies* and various hardwoods until December (S2), common. Very common in Greece, reported from a large variety of habitats.

***Mycena rosella*** (Fr.) P. Kummer

On *P. nigra* needles, gregarious, September-November (S4). Only one previous record in Greece from the same habitat (Maire & Politis 1940).

***Mycena stipata*** Maas G. & Schwöbel

On dead wood in mixed forests of *A. cephalonica* and *P. nigra*, October-November, common (S5, S3). Very common in Greece, mainly recorded in coniferous woods and reported both as *M. stipata* and *M. alcalina* p.p.

***Oligoporus caesius*** (Schrad.) Gilb. & Ryvarden

On dead wood of *A. cephalonica*, solitary or imbricate, November (S4). Rather common in Greece.

***Oligoporus fragilis*** (Fr.) Gilb. & Ryvarden

On dead wood of *A. cephalonica,* imbricate, November (S4). Upper and pore surfaces turning reddish-brown on bruising or drying. Widespread in the coniferous forest of Europe, but extremely rare in the southern region. One previous record from the same substrate in Mt. Oxya (Dimou & al. 2001).

†***Onnia tomentosa*** (Fr.) P. Karst.

In *A. cephalonica* forest, rare, solitary, September and December 2000 (S2). Rare in Greece; recorded previously in *P. sylvestris* (Diamandis & Perlerou 1990), and in *A cephalonica* (Dimou & al., unpublished results).

†***Panaeolus acuminatus*** (Schaeff.) Quél.

On grass in *P. nigra* and *A. cephalonica* forests, solitary, rare, November 1999 (S3). Few previous reports from Greece as *P. rickenii* Hora.

†***Panaeolus sphinctrinus*** (Fr.) Quél.

On soil close to horse dung, solitary, not common in the coniferous forest, October (S4). Shape and size of spores agrees with descriptions by Watling & Gregory (1987), but according to Breitenbach & Kränzlin (1995) *P. papilionaceus* (Bull.) Quél. is considered as a synonym. Several previous records from Greece.

†***Paxillus atrotomentosus*** (Batsch.) Fr.
On dead burned *P. nigra* stump, solitary or in clusters, October 1999 (S5). Only two previous records from pine forests in Greece (Pantidou 1990, Diamandis 1992).

***Peniophora piceae*** (Pers.) J. Erikss.
On attached branches of *A. cephalonica*, resupinate, December 1999 (Nedousa). Only two previous reports from central and northern Greece on fir wood (Minter 1988, Diamandis 1992).

†***Phaeolus schweinitzii*** (Fr.) Pat.
On *A. cephalonica* roots, rare, collected twice in October 1997 and 1999 (S4, S3). Common on *Pinus* in the northern part of the country and on *A. borisii-regis* (Diamandis & Perlerou 1990), this is the first record from the southern part of the country on this host (Zervakis & al. 1998).

***Phellinus hartigii*** (Allesch. & Schnabl) Pat.
On dead trunk of *A. cephalonica*, solitary, September (S4). Rather common in Greece, reported mainly from coniferous woods (Zervakis & al. 1998).

***Phellodon niger*** (Fr.) P. Karst.
In mixed *A. cephalonica* and *Q. coccifera* forests, gregarious, in rows, rare, November-December 1999 (S2). Only two previous reports from Greece in conifer woods (Diamandis & Minter 1981, Avtzis & Diamandis 1988).

†***Phellodon tomentosus*** (L.) Baker
In mixed *A. cephalonica* and *Q. coccifera* forests, gregarious, in rows, November-December 1999 (S2). One previous report in conifers from Mt. Taygetos as *Calodon tomentosus* (Fr.) Donk (Maire & Politis 1940).

†***Phlebia queletii*** (Bourd. & Galz.) M.P. Christ.
On branches of *A. cephalonica*, resupinate, December 1999 (S2). Only one previous report from central Greece on fir wood (Minter 1988).

†***Pholiota highlandensis*** (Peck) Hesler & A.H. Sm.
In *P. nigra* and *A. cephalonica* forests around burned stumps, in clusters, extremely abundant in all burned forest area, end of September to mid-December 1999, also in February-May 2000 (even at high elevations with snow) (S3). This easy to identify taxon is one of the most common inhabitants of burned places in Mt. Taygetos, observed during the entire year. Three previous records from Greece: by Maire & Politis (1940) as *Gymnopilus carbonarius* (Fr.) Murrill in *Fagus* sp. from Mt. Ossa, in Naxos island around a burned *Juniperus phoenicea* L. tree (Polemis & al. 2000) and from *Fagus* forest of Oxya Mt. in a fire-bone place. (Dimou & al. 2002).

****Pholiota limonella*** (Peck) Sacc.
On dead conifer wood, in clusters, October 1999 (S4). Macroscopically difficult to be distinguished from *P. cerifera* (P. Karst.) P. Karst. However, the latter grows only on hardwood, and has larger basidiospores (8-10 x 5-6 μm instead of 6-8 x 4-5 μm) (Breitenbach & Kränzlin 1995, Hansen & Knudsen 1992).

†***Pisolithus arhizus*** (Scop.) Rauschert
In *P. nigra* forest, rare, solitary, October 1996 (S3). Although reported in Greece only twice in the past (Maire & Politis 1940, Polemis 1998), many specimens were recently recorded in areas of southern Peloponnese and in other regions in a wide variety of habitats (Zervakis & al., submitted; Dimou & al., unpublished data). However this constitutes the first record from *P. nigra* forests.

***Pleurotus ostreatus*** (Jacq.) P. Kummer
On dead *A. cephalonica* trunk, imbricate, not common collected only twice in December 1999 (S2, S4). Common in Greece (Zervakis & Balis 1996, Zervakis & al. 1998).

***Pluteus pouzarianus*** Singer
On rotten trunk of *A. cephalonica*, on woody remains of conifers, solitary, not common, September-October 1999 but also collected in May 1999 (S3, S4). All collections have scattered clamps in the hyphae of the pileipellis; this is a distinguishing character from *P. cervinus* that has no clamps and grows on hardwood, and from *P. primus* that has clamps on all septa (Breitenbach & Kränzlin 1995, Hansen & Knudsen 1992).

†***Pluteus tricuspidatus*** Velen.
On rotten *P. nigra* trunk, solitary, rare, end of October (S3). Uncommon in Greece, previously reported from fir and spruce forests as *P. atromarginatus* (Kühner & Romagn.) Singer (Diamandis & Perlerou 1990, Diamandis 1992, Diamandis & Perlerou 1994).

***Podofomes trogii*** (Fr.) Pouzar
Rare, recorded only twice in the Mt. Taygetos (October 1996 and September 1999), on wood debris beside stumps and fallen trunks of *A. cephalonica*, solitary (S2, S4). The stipitate basidiomata of this taxon are typical and easy to recognize. It is considered restricted to *Abies alba* and rarely (if ever) on *Picea* (Ryvarden & Gilbertson 1993). This is the first ever record of *Abies cephalonica* as a host species.

****Psathyrella olympiana* f. *caespitosa*** Kits v. Wav.
In clusters of 20-30 basidiomata, September–October 1999, on the base of a burned *P. nigra* tree (S3), and on the base of a living *A. cephalonica* tree (S4). The dark reddish to purplish brown pilei with white fibrillose scales when young, the metuloid cheilo- and pleurocystidia (some incrusted apically), and the spores measuring 7.5-9 x 4.2-5.2 μm are the main diagnostic features of this species. Characteristic of this form is the caespitose mode of growth and the drying out of pileus margin instead of center (van Waveren 1985).

****Psathyrella pennata*** (Fr.) Konrad & Maubl.
In burned *P. nigra* and *A. cephalonica* forest, abundant in the entire area of the burned part of the forest), from the end of September to the end of October 1999 and 2000 (S3). Another morphologically closely resembling inhabitant of burned areas is *P. gossypina* (Bull.) A. Pearson & Dennis; the latter usually bears umbonate pileus, thin-walled ventricose and elongated at apex to a narrow neck with large globose or irregularly shaped oily inclusions (van Waveren 1985). Our specimens had basidiomata with parabolic pileus and thick-walled pointed cystidia without oily inclusions. In addition, only *P. pennata* is characterized by such a habitat, and very rarely *P. gossypina* (Moser 1983).

†***Psathyrella spadicea*** (Schaeff.) Singer
On wood of *Acer* sp., fasciculate, not common, November 1999 (S4). Cheilo- and pleurocystidia fusiform to ventricose with thickened wall at the apex (apex covered with crystals), cystidia 45-65 x 13-20 μm, spores ellipsoid to phaseoliform 8-11 x 4.5-5.5 μm (van Waveren 1985). One previous report from Aroania Mts. (Delivorias & Gonou-Zagou 2000).

***Pseudohydnum gelatinosum*** (Scop.) P. Karst.
On rotten wood and woody remains of *A. cephalonica*, solitary-gregarious, September - December (S4). Common in Greece on conifer wood.

***Psilocybe coprophila*** (Bull.) P. Kummer
In field on cow dung, September, rare (S2). Considered to be a common species although previously recorded only twice (Maire & Politis 1940, Diamandis 1985); the former as *Deconica coprophila* (Fr.: Bull.) Sacc. from the same substrate and location.

†***Radulomyces confluens*** (Fr.) M.P. Christ.
On rotten wood of *A. cephalonica*, resupinate, December 1999 (S2). Previously recorded in central Greece as *Cerocorticium confluens* (Fr.) Jülich & Stalpers on *Abies* sp. (Minter 1988)

and in Peloponnese on *Amaryllis foetida* (Kotlaba & Klan 1994).

***Ramaria aurea*** (Schaeff.) Quél.
In *A. cephalonica* forest on mossy stands, solitary, common, October-November (S2, S3), and in *P. nigra* & *A. cephalonica*, October (S4. Abundant in Greece, reported mainly in coniferous forests.

***Ramaria flaccida*** (Fr.) Bourd.
On mossy stands, in mixed forests of *A. cephalonica* and *Q. coccifera*, gregarious in rows, September-December 1999 and 2000 (S2). Our specimens had echinulate spores, 6.3-8 x 3.5-4.2 µm, with spines up to 0.6 µm long. The similar taxon *R. eumorpha* (P. Karst.) Corner has longer spores, 7-10 x 3.5-5.5 µm, and spines up to 1.5 µm (Hansen & Knudsen 1997). Only two other records from Greece (Delivorias & Gonou-Zagou 2000, Zervakis & al., submitted).

***Ramaria flava*** (Scaeff.) Quél.
In mixed forests of *A. cephalonica* and *P. nigra*, relatively common, September-November (S3, S4). Rather common in Greece.

*****Ramaria largentii*** Marr & Stuntz
In mixed *A. cephalonica* and *Q. coccifera* forests, and in *P. nigra* and *A. cephalonica* forests, gregarious in rows, November (S2, S3, S4). This species is macroscopically very similar to *R. aurea*, but it has hyphae and basidia with clamps (not in *R. aurea*), and much longer spores, 11-15 x 3.5-4.8 µm.

*****Ramaria obtusissima*** (Peck) Corner
In *P. nigra* forest, in October-November 1996, rare (S3), and in *P. nigra* and *A. cephalonica*, in September-December 1999 (S4), gregarious in rows, localy common. This species has hyphae without clamps and smooth spores.

***Ramaria pallida*** (Schaeff.) Ricken
In *A. cephalonica* forest, rather common, among grass, October (S3). Two previous records from Greece in *Abies borisii-regis* and *A. cephalonica* (Diamandis & Perlerou 1990, Diamandis 1992).

*****Ramaria stricta*** (Fr.) Quél.
In *A. cephalonica* among grass, collected only during October 1996 and 1997 autumn seasons (S3). It produces abundant dense white rhizomorphs, and multiple parallel vertical branches beginning immediately above the trunk. It has thick-walled skeletal hyphae, spores broadly elliptical and slightly verrucose, hyaline with drops, 7-9.5 x 3.8-4.6 µm.

***Rhizopogon obtextus*** (Spreng.) Rauschert (syn. *R. luteolus* Fr.)
In *P. nigra* forest, very common, October-November (S3, S4). Relatively common in Greece (but possibly overlooked), in coniferous habitats (Maire & Politis 1940, Pantidou 1973, Pantidou 1980).

***Rhizopogon roseolus*** (Corda) Fr.
In *P. nigra* forest, common, October-November (S3, S4). Curiously enough only two previous reports from Greece, in coniferous habitats (Pantidou 1990, Athanasiou & Theochari 1999).

*****Rhizopogon vulgaris*** (Vittad.) M. Lange
In *P. nigra* and *A. cephalonica* forests, October 2000 (Mavra Litharia). Similar to *R. luteolus* but with distinctly smaller spores (Pegler & al. 1995). Our specimens had spores smaller than 7.5 x 3.0 µm.

†***Rhodocybe gemina*** (Fr.) Kuyper & Noordel.
On humus under *A. cephalonica*, in groups, December 1999 (S2). Only two previous records from Greece (Minter 1988, as *R. truncata* (Schaeff.) Singer; Zervakis & al., submitted).

***Rhodocybe nitellina*** (Fr.) Singer
In mixed forests of *P. nigra* and *A. cephalonica*, relatively common, October (S3). Only one previous record from Greece, in Mt. Mainalon (Arkadia) on the same habitat (Pantidou 1980).

****Russula acrifolia*** Romagn.
In *P. nigra* and *A. cephalonica* forests, solitary, October-December 1996 and 1998 (S2, S4). All the collected specimens produce a white spore-print and a typical flesh discoloration (first reddening, then slowly graying), have gray-brown pileus and stipe, and their lamellae have a distinctly acrid taste.

****Russula amethystina*** Quél.
In mixed forests of *P. nigra* and *A. cephalonica*, relatively rare, October 1996 and 1998 (S4). This species has lilac to wine-red to red-brown pilei with yellowish centre, and warty basidiospores measuring 7.4-9.2 x 5.8-7.8 μm.

***Russula delica*** Fr.
In *P. nigra* and *A. cephalonica* forests, very common, October-December (S2, S3, S4, S5). The most often cited *Russula* species in Greece (however this is the first record from Peloponnese), reported in a wide variety of habitats.

****Russula densifolia*** Gill.
In mixed forests of *A. cephalonica*, *J. oxycedrus* and *Q. coccifera*, rare, September-October 1996 and 1997 (S2). This taxon belongs to the section *Compactae* (sensu Moser); it produces medium-sized matt pilei (7-11 cm), when young whitish but soon gray brown to brown with olivaceous tones and a whitish margin, and a white spore-print; the lamellae are distinctly crowded and have a slightly sharp taste.

†***Russula integra*** L. ss. Maire
In *Pinus nigra* and *A. cephalonica* forests, common, September-December (S3, S4, Nedousa). Reported only twice in the past in fir forests (Diamandis & Minter 1983, Diamandis 1985).

†***Russula ochroleuca*** Pers.
In pastures close to *A. cephalonica*, relatively common, September-October (S2). Recorded only once in the past from hardwood forests (Diamandis 1992).

****Russula pallidospora*** Romagn.
In mixed forests of *A. cephalonica*, *J. oxycedrus* and *Q. coccifera*, rare, September-October 1996 and 1997 (S2). All species belonging to the section *Compactae* (sensu Moser) are characterized by the relatively large (10-14 cm) dirty white to yellowish basidiomata, the finely spiny to ridged spores (7.4-10.0 x 6.2-7.8 μm), the white spore-print and the distant cream lamellae.

***Russula rosea*** Pers.
In mixed forests of *A. cephalonica*, *J. oxycedrus* and *Q. coccifera*, relatively common, September-October (S2). Relatively rare in Greece, reported only twice in the past from mixed forests as *R. lepida* Fr. (Maire & Politis 1940, Athanasiou & Theochari 1999).

***Russula sardonia*** Fr.
In *P. nigra* forest, common, October-November (S3). Relatively common in Greece in coniferous habitats of central and northern areas.

***Russula torulosa*** Bres.
In *P. nigra* forest, solitary, September and November (S3). Only one previous record from Greece (Athanasiou & Theochari 1999).

†***Russula turci*** Bres. ss. Maire
In *P. nigra* and *A. cephalonica* forests, common, September-November (S3, S4). Only one

record in the past from *Pinus* sp. and *Picea abies* (Diamandis 1992).

†***Russula xerampelina*** (Schaeff.) Fr. ss. str.
In *A. cephalonica* and in *P. nigra* forests, common, September-November (S3, S4). Only one record in the past from a beech forest (Maire & Politis 1940).

†***Sarcodon leucopus*** (Pers.) Maas G. & Nannf.
In *P. nigra* and *A. cephalonica* forests, solitary, rare, October 1996 (S5) and November 1999 (Neochori–Perdikoneri). One previous report in *P. nigra* from Mt. Taygetos under the name *Sarcodon laevigatus* (Fr.) Quél. (Maire & Politis 1940).

†***Schizophyllum commune*** Fr.
On *A. cephalonica* stump, April 1997, relatively rare (Karveli), on *P. nigra* logs appearing in large numbers in snow covered area in February 2000 (Neochori cross-road, burned forest). Very common throughout Greece on a wide variety of substrates (Zervakis & al. 1998); however, this is the first record on *P. nigra* wood.

†***Scleroderma polyrhizum*** (J.F. Gmel.) Pers.
In pastures close to *A. cephalonica*, relatively common, September-October (S2). Previously recorded in *A. cephalonica* from Mt. Oxya (Dimou & al., unpublished data), in field (Maire & Politis 1940), and in broadleaved forests (Minter 1988, Diamandis & Perlerou 1990).

****Sistotrema brinkmannii*** (Bres.) J. Erikss.
On rotten wood of *P. nigra*, December 1999 (S4). Basidioma resupinate, effused, soft, white-cream-coloured. Hymenium more or less grandinioid.

****Skeletocutis amorpha*** (Fr.) Kotl. & Pouzar
On dead branch of *P. nigra*, resupinate, December 1999 (Artemisia). Easy to recognise by the pale orange cartilaginous tube layer. Older specimens could be confused with *S. carneogrisea* and have to be examined microscopically.

***Stereum sanguinolentum*** (Alb. & Schwein.) Fr.
On *P. nigra*, rather rare, throughout the year (S3, S4). Relatively rare in Greece, reported only twice in the past on *Pinus* spp. and *Abies* sp. (Maire & Politis 1940, Minter 1988).

****Strobilurus stephanocystis*** (Hora) Singer
On buried *P. nigra* cones, gregarious, locally abundant, April-May 1999 and 2000 (S4, S3). Previously recorded in Mt. Oxya on the same host (Dimou & al., unpublished results). Almost identical macroscopically with *S. tenacellus* and sharing the same habitat. However, it is clearly distinguished by the short, thick, clavate cheilocystidia and pleurocystidia (as opposed to the fusiform cystidia in *S. tenacellus*), and spores 6-10 x 3-4 µm (4.5-6.5 x 2.0-2.5 µm in *S. tenacellus*) (Breitenbach & Kränzlin 1991).

***Strobilurus tenacellus*** (Pers.) Singer
On buried *P. nigra* cones, locally abundant, April-May (S4, S3). Relatively common in Greece on *Pinus* spp.

***Stropharia aeruginosa*** (Curt.) Quél.
On humus, needles and twigs of *P. nigra* & *A. cephalonica*, gregarious, November-December (S4). Common in Greece in various habitats.

***Suillus abietinus*** Pantidou & Watling
In mixed forests of *P. nigra* and *A. cephalonica*, relatively common, October - November (S3). Recorded only once in the past in *A. cephalonica* from Vytina (Arkadia) (Pantidou & Watling 1970).

***Suillus bovinus*** (Fr.) Kuntze
In *P. nigra*, solitary or in clusters, abundant, September (S3). Reported only twice in the past

from Greece in pine forests (Diamandis 1992, Athanasiou & Theochari 1999).

***Suillus collinitus*** Fr.
In *P. nigra* forest,common, September-November (S3, S4). Recorded only from pine forests in Greece (Pantidou & Watling 1970, Athanasiou & Theochari 1999).

***Suillus granulatus*** (Fr.) O. Kuntze
In *P. nigra* and in *P. nigra* and *A. cephalonica* forests, abundant, growing solitary or in small clusters, September–October but also collected in June once (S3, S4). Relatively common in Greece.

***Suillus luteus*** (L.) Gray
In *P. nigra*, common, growing solitary and in small groups, September-December (S3, S4, Perdikoneri-Neochori). Relatively common in Greece in coniferous habitats.

†***Suillus obscurus*** Pantidou & Watling
In *P. nigra*, relatively common, September-October (S3). Recorded once before in *P. halepensis* (Pantidou & Watling 1970).

***Trametes versicolor*** (L.) Pilát
On *A. cephalonica* stumps, throughout the year, common (S3, S4). Very common throughout Greece, on a large variety of substrates.

†***Trechispora farinacea*** (Pers.) Liberta
On cavities of dead wood, or underside of rotten wood of *P. nigra* and *A. cephalonica*, resupinate, relatively common and widespread, December 1999 (S4). Only one report in the past from hardwood in northern Greece (Minter 1988).

***Tremiscus helvelloides*** (DC.) Donk
On woody remains of *A. cephalonica*, December (Manesis-Neochori). Rather common in fir forests of Greece.

***Trichaptum abietinum*** (Dicks.) Ryvarden
On *A. cephalonica* logs and stumps, very common, throughout the year (S2, S3, S4, S5). Very common throughout Greece.

***Trichaptum fuscoviolaceum*** (Ehrenb.) Ryvarden
On dead trunks and branches of *P. nigra*, effused-reflected, common and widespread, all year (S2, S3, S4). This is the first record from southern Greece; reported only once in the past from the same host (Diamandis & Perlerou 1990).

***Tricholoma atrosquamosum*** (Chev.) Sacc.
In *A. cephalonica* forest, common, September-October (S2). Relatively common in Greece, mainly reported from coniferous woods.

***Tricholoma aurantium*** (Schaeff.) Ricken
In mixed forests of *A. cephalonica* and *P. nigra*, October-December, relatively common, (S2, S3, S4). Common in Greece, mainly reported from coniferous woods (Zervakis & al. 1998).

***Tricholoma bufonium*** (Pers.) Gill.
In *P. nigra* and *A. cephalonica* forests, solitary, November 1999 (S4). This species presents violet-brown pileus and grows in conifers, whereas the closely related *T. sulphureum* has a yellow pileus and grows in hardwoods. Only one previous record (Delivorias & Gonou-Zagou 2000).

***Tricholoma imbricatum*** (Fr.) P. Kummer
In *P. nigra* and *A. cephalonica* forests, in clusters or gregarious, October 1999 (S3). Only one previous record in the past, again from Mt. Taygetos in *P. nigra* (Maire & Politis 1940).

***Tricholoma luridum** (Schaeff.) P. Kummer
In *P. nigra* and *A. cephalonica* forests, solitary, June 2000 (Vasiliki forest). It is a member of the subgenus *Tricholoma* section *Tricholoma* and differs from the similar *T. sejunctum* by having larger spores (7-10.5(11) x 6-8(8.5) µm) and not a bitter taste (Hansen & Knudsen 1992, Breitenbach & Kränzlin 1991).

†***Tricholoma nauseosum*** (Blytt.) Kytöv.
In *P. nigra* and *A. cephalonica* forests, solitary, end of October 1999 (S4). Rather uncommon in Greece, reported from *Arbutus unedo* and *Pinus* spp. as *Tricholoma caligatum* (Viv.) Ricken (Pantidou 1990, Diamandis 1992, Athanasiou & Theochari 1999). First host record in Greece for *A. cephalonica*.

***Tricholoma saponaceum*** (Fr.) P. Kummer
In *P. nigra* and *A. cephalonica* forests, solitary, relatively common, October-December (S4). Rather common in Greece, reported only from conifer forests (Zervakis & al. 1998).

****Tricholoma scalpturatum*** Quél.
In mossy stands in *A. cephalonica* forest, September-October, common (S2). This species is characterized by grey to grey-brown pilei with fine fibres, dirty brown to yellow lamellae and a white fibrous stipe; it also has a ring-like greyish cortina.

***Tricholoma squarrulosum*** Bres.
In *A. cephalonica* forest, common, October-November (S3). Relatively common in Greece.

****Tricholoma stans*** (Fr.) Sacc.
In *P. nigr* forest,, relatively common, collected in large numbers during the October-November 1998 season (S3). Specimens are characterized by slightly fibrous red-brown to brown pilei and white-cream lamellae with red-brown spots; flesh is bitter and reddens when hurt, spores 5.8-6.7 x 3.6-4.0 µm.

***Tricholoma terreum*** (Schaeff.) P. Kummer
In *P. nigra* and *A. cephalonica* forests (S4) or in mixed forest (S2), solitary to gregarius, common, October-December. Common in Greece, recorded only in conifer forests.

***Tricholomopsis rutilans*** (Schaeff.) Singer
On wood debris in *A. cephalonica*, relatively common, October-November (S2). Common in Greece, reported only from coniferous woods.

***Tubaria furfuracea*** (Pers.) Gill.
In *P. nigra*, relatively common, October-November (S5). A relatively common species in Greece.

†***Tubulicrinis gracillimus*** (Ell.& Everh.) G. H. Cunn.
On rotten wood of *A. cephalonica*, December 1999 (Nedousa). Only one previous record from Crete on *Pinus brutia* as *Peniophora glebulosa* Bres. (Petrak 1943).

****Tubulicrinis subulatus*** (Bourd. & Galz.) Donk
On wood of *A. cephalonica*, resupinate, December-March (S2, S4). Basidioma resupinate, membranous, very thin, white to cream coloured.

***Tulostoma brumale*** Pers.
On grassy–mossy soil, clearing in a mixed forest, solitary to gregarious, November-December but also in May (S2). Only two previous records from northern Greece (Minter 1988, Diamandis 1992).

†***Vesiculomyces citrinus*** (Pers.) Hagström
On dead wood of *P. nigra* and *A. cephalonica*, resupinate, relatively common and widespread, November-December (S4). Reported only once in the past from central Greece on *Juniperus* sp.

(Minter 1988).

***Xerocomus chrysenteron*** (Bull.) Quél.
In *P. nigra* forest, common, growing solitary, September-October (S3, S4); collected also in May 1999 and fruited in great numbers until mid–November of the same year (S3, S4). Common in Greece in a wide variety of habitats.

***Xerula melanotricha*** Dörfelt
In *P. nigra* and *A. cephalonica* forests, solitary, September-December (S2, S4). Common in Greece in fir habitats, previously reported as *Oudemansiella longipes* (Bull.: St. Amans) Moser or as *Xerula longipes* (Bull.) Maire (Zervakis & al. 1998).

## DISCUSSION

The succession of the most common species of macrofungi were as follows in the area under study (strongly dependent on the weather conditions as regards the exact date of appearance and possible overlapping in occurrence): Late August or September: *Amanita muscaria*, *A. rubescens*, *Boletus luridiformis*, *Chroogomphus rutilus*, *Clitocybe odora*, *Exidia pithya*, *Lactarius deliciosus*, *Lycoperdon perlatum*, *Macrolepiota procera*, *Suillus granulatus*, *S. luteus*, *Ramaria aurea*, *Russula integra*, *R. xerampelina*, *Xerocomus chrysenteron*. From late September or early October: *Clavulina cinerea*, *Cystoderma granulosum*, *Galerina unicolor*, *Gymnopilus penetrans*, *Hebeloma sinapizans*, *Inocybe bongardii*, *Laccaria laccata*, *Lyophyllum fumosum*, *Marasmius androsaceus*, *Mycena epipterygia*, *M. pura*, *M. stipata*, *Psathyrella pennata*, *Tricholoma atrosquamosum*, *T. scalpturatum*. October or November: *Agaricus pampeanus*, *Cantharellus cibarius*, *Cortinarius dibaphus*, *C. odorifer*, *Geastrum sessile*, *Gomphidius glutinosus*, *Helvella lacunosa*, *Hygrophorus pudorinus*, *Rhodocybe nitellina*, *Stropharia aeruginosa*. Late November or winter months: *Lepista luscina*, *Lentinellus castoreus*, *Pholiota highlandensis*, *Pleurotus ostreatus*, *Pithya vulgaris*, *Schizophyllum commune*, and Stereales. April to early June: *Amanita gemmata*, *Boletus pinophilus*, *Entoloma incanum*, *Exidia pithya*, *Melanoleuca cognata*, *Pluteus puzarianus*, *Tricholoma luridum*, *Xerocomus chrysenteron*, and the rest of the ascomycetes.

Noteworthy were the autumn seasons in 1996 and 1999, as well as the spring season of 1999. Huge numbers of ascomata were observed in this latter period, especially in the burned part of the forest (Site 3 was partly affected from a large fire which burned 2,500 hectares in Mt. Taygetos during July-August 1998). Hence, many important findings were recorded from late April to early June of 1999 (and in the upcoming years), including: *Coprinus angulatus*, *Fayodia maura*, *Lyophyllum sphaerosporum*, *Pholiota highlandensis*, *Psathyrella pennata*, *P. olympiana*, *Faerberia carbonaria*, *Geopyxis carbonaria*, *Gyromitra esculenta*, *G. infula*, *Morchella conica*, *Paxina leucomelas*, *Peziza violacea*, and *Plicaria trachycarpa* (most of them constitute new species records for Greece). Later during the same year, the combination of increased rainfalls (78.8 mm) in September and the relatively high temperatures (18.2 °C) in October (as oppposed to 7 mm and 15.0 °C in 1997, 25 mm and 17.7 °C in 1998, and 13.8 mm and 15.7 °C in 2000) led to the appearance of a much larger number of species. Species like *Amanita echinocephala*, *A. franchetii*, *Boletus pinophilus*, *Albatrellus cristatus*, *Leucoagaricus subcretaceus*, *Hydnellum* spp., *Phellodon* spp., *Sarcodon leucopus*, *Limacella ilinita*, etc. appeared only during this year within the entire period of the present study. In the autumn of 1996, appearance of mushrooms began from late August (a quite extraordinary event for the climatic conditions of southern Greece) and continued throughout this season facilitated by early and then regular rainfalls in conjunction with relatively high temperatures. This period was characterized by the abundance of many *Boletus* spp. (incl. *B. appendiculatus*, *B. calopus*, *B. splendidus* ssp. *moseri*), *Russula densifolia*, *R. pallidospora*, *R. xerampelina*, *Clitocybe odora*, *C. sinopica*, *Ramaria* spp., *Tricholoma scalpturatum*, *Lycoperdon pyriforme*, *Suillus* spp., etc.;

some of which again were only recorded during this particular year.

An analysis of the ratio of mycorrhizal, biotrophic, saprotrophic (on humus, wood and dung) per site appears in Table 1, and is indicative of the ecological status of the particular biotopes (Fellner 1993). Out of the total of the findings of this study, most were saprotrophic on humus (36%), mycorrhizal (33%) and saprotrophic on wood (29%), whereas very few specimens were biotrophic on trees or coprophilous. As concerns individual areas of study, Site 2 was dominated by macromycetes growing on humus (including plant debris and leaves) (41%), Site 3 by ectomycorrhizae (40%) and species saprotrophic on humus (38%), and Site 4 by saprotrophic on wood (38%) and mycorrhizal (35%). The latter is undergoing systematic logging, Site 3 includes many relatively young conifers, while in Site 2 presents the largest variety in the number of herbaceous and other plants below the tree canopy.

**Table 1.** Distribution of macrofungi (and frequency percentages) according to their ecotrophic preferences and site of occurrence (S2, S3, S4 or other) in the areas under study of Mt. Taygetos

| | Total | Saprotrophic (humus)* | Saprotrophic (wood | Saprotrophic (dung) | Biotrophic | Mycorrhizal |
|---|---|---|---|---|---|---|
| S2 | 92 | 38 (41.3%) | 25 (27.2%) | 1 (1.1%) | 1 (1.1%) | 28 (30.4%) |
| S3 | 113 | 43 (38.1%) | 23 (20.3%) | - | - | 46 (40.7%) |
| S4 | 139 | 33 (23.7%) | 53 (38.1%) | 1 (0.7%) | 1 (0.7%) | 49 (35.3%) |
| Other | 42 | 16 (38.1%) | 13 (31.0%) | - | - | 12 (28.6%) |
| Total** | 265 | 95 (35.9%) | 78 (29.4%) | 2 (0.8%) | 2 (0.8%) | 87 (32.8%) |

* includes macrofungi collected from soil, leaf litter and plant debris

** the figures could be summed up only along the lines (not across the columns since many specimens were collected from more than one site)

The N-NW orientation of S2 makes this site susceptible to the effect of air pollutants carried by dominating winds from the near-by thermoelectric plant of Megalopoli. The increased presence of biotrophic fungi in the greater area has not been correlated yet with the operation of this plant, although numerous infected and dead conifer trees were detected in the greater area (P. Tsopelas, personal communication).

Collection of edible mushrooms is limited (mainly to *Pleurotus ostreatus*, *Macrolepiota procera*, and *Lactarius deliciosus*) and is exercised by a few inhabitants of the neighbouring villages and from the urban area of Kalamata. The only noteworthy exception has been the irrational harvest of morels during the spring of 1999 (after the forest fire of the previous summer) by foreigners who transported large quantities of mushrooms to northern Greece and after drying them to Italy and France.

Forest fires, grazing, illegal privatization of forest areas and subsequent building of resort houses, as well as recreation activities seem to pose the main threats to biodiversity in Mt. Taygetos. Appropriate measures for the conservation of the mycoflora is the prohibition of grazing (at least at vulnerables sites of particular biodiversity value), strict enforcement of existing laws concerning building activities within forest regions, intensification of fire-prevention measures, and establishment of protected areas within the greater Mt. Taygetos region (any anthropogenic activity should be minimized). In addition, of great need is the establishment of a national law regulating harvest of wild mushrooms, since there is a lack of any type of pertinent legislation in Greece.

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# ALTERNARIA THEMES AND VARIATIONS (305-309)
## LEWIA/ALTERNARIA REVISITED

EMORY G. SIMMONS

*717 Thornwood Road, Crawfordsville, IN 47933*

### *ABSTRACT*

A continuation of a series of papers primarily on *Alternaria*, in this instance on the *Alternaria* states of two *Lewia* species and on an additional three *Alternaria* taxa without known teleomorphs. All five of the *Alternaria* taxa exhibit the sporulation pattern of the *A. infectoria* species-group. All taxa discussed here are described as novel: *L. viburni* and *A. viburni* (on *Viburnum* sp.), *L. intercepta* and *A. intercepta* (on *Viburnum* sp.), *A. merytae* (on *Meryta sinclairii*), *A. humuli* (on *Humulus lupulus*), and *A. novae-zelandiae* (on *Daucus carota*).

**Additional Keywords**: *Alternaria infectoria* species-group, *Daucus*, *Humulus*, *Meryta*, *Viburnum*.

## XXX. LEWIA ANAMORPHS ON VIBURNUM AND OTHER SUBSTRATES

### Introduction

Holomorphic unity has been established for ascomycetous *Lewia* Barr & Simmons (Simmons 1986) and a distinctive portion of hyphomycetous *Alternaria* Nees (1816) on the basis of isolates derived from single asci and ascospores of *Lewia* (Simmons 1986). Continuing work with the genus emphasizes three observations noted in the 1986 paper or derived from subsequent culture studies and the literature:

1. The *Alternaria* taxa of the relationship are restricted to members of a commonly-encountered group of species that sporulate in branching patterns characteristic of a species-group represented by *A. infectoria* Simmons (1986). Several kinds of information support the taxonomic

distinctness of this *A. infectoria* species-group from other sporulation groups in *Alternaria*: morphologic (Simmons and Roberts 1993, Simmons 1999); molecular (Roberts et al. 2000); and metabolic (Andersen et al. 2002). Known anamorphs of *Lewia* do not occur among taxa of other *Alternaria* sporulation groups (Simmons and Roberts 1993), such as those represented by the commonly misidentified small-spored *A. alternata* (Fr.) Keissler (1912), *A. tenuissima* (Nees) Wiltshire (1933), and *A. arborescens* Simmons (1999), or by any of the relatively large-spored phytopathogens of the genus.

2. As observed by Crivelli (1983) and maintained in subsequent studies (Simmons 1986), the differences among ex-ascospore *Alternaria* cultures of this *A. infectoria* species-group may be stable and of diagnostic value, whereas variation in morphology of the ascomatous sources often is comparatively insignificant. Thus, in *Alternaria* as, for example, in *Stemphylium* Wallr. (1833), character differences between anamorphs can lead to discovery of diagnostically usable morphologic differences in their teleomorphs. (For the *Stemphylium* examples, see Simmons 2001 and papers cited in that place.)

3. As of this writing, there is no convincing published evidence that anyone has succeeded in obtaining an *Alternaria*-related teleomorph in controlled axenic culture. Simmons (1986) thought that he had succeeded with "*Alternaria eureka* Simmons," only to decide, on reflection, that somewhat similar *Embellisia* Simmons (1971) was a better placement for *Embellisia eureka* (Simmons) Simmons and its teleomorph *Allewia eureka* (Simmons) Simmons (1990).

When grown under standard conditions (potato/carrot agar, ca 20C, 8/16 hr. cool-white fluorescent light/dark cycle), isolates of taxa belonging to the *A. infectoria* species-group have an initial strong tendency to produce colonies with conspicuous amounts of non-sporulating mycelium. Colonies 3-4 d. old often are almost entirely arachnoid, cottony, or wooly; sporulation on such aerial hyphae tends to be scattered and sparse. As sporulation progresses, it usually remains scattered and relatively minor in the aerial mycelium but characteristically begins to occur in branching clusters that arise directly from the substrate. The conidial population of each clump may be only a few spores, or it may be composed of several hundred spore units.

For some isolates of this *A. infectoria* group these clumps are scattered within or beneath the aerial mycelium; for others, great numbers of bushy sporulation clumps crowd into a dense layer at the agar surface. The unaided eye can readily see that the layer, even in its crowded condition, is composed of discrete sporulation clumps and is not simply a continuous lawn of conidial chains. Each clump develops at the apex of a single conidiophore (usually) or of a bundle of a few somewhat weak, closely parallel conidiophores; these primary conidiophores usually lengthen by means of apical geniculate extensions. However, the primary conidiophore in the *A. infectoria* species-group remains relatively short, in the sense that it does not evolve into the kind of very long, erect, dark, subrigid primary conidiophore that characterizes the sporulation apparatus of the *A. arborescens* species-group (Simmons 1999).

Production of relatively long secondary conidiophores between some conidia in the process of chain formation is a primary diagnostic feature of the *A. infectoria* species-group. In some species (e.g., *A. viburni* below, Fig. 219; and especially *A. merytae*, Fig. 221), production of long, strongly geniculate secondary conidiophores is a striking, even dominant aspect of the sporulation apparatus. In other species, (e.g., *A. humuli*, Fig. 222; *A. novae-zelandiae*, Fig. 223), the first conidia produced at ca. 2d. of colony growth often produce exceptionally long apical conidiophores, but later only one or two secondary conidiophores of unusual length are produced in chains of the sporulation cluster.

## 305—306. New *Lewia/Alternaria* Taxa on *Viburnum*

During several months of 2001, numerous shipments of horticultural *Viburnum* material were intercepted by USDA Animal and Plant Health Inspection Service (APHIS) staff at U.S. ports of entry because of abundant ascomata present on the stems. Specimens were submitted to the APHIS fungus pest specialists at USDA, Beltsville, Maryland (Drs. John McKemy and Mary E. Palm) for identification. Mature ascomata of at least two *Lewia* taxa were present on the material, which arrived from but was not necessarily produced in The Netherlands. No pertinent species descriptions in likely genera (*Pleospora*, *Sphaeria*, *Lewia*) have been found for *Viburnum* L. or other genera of its family, the Caprifoliaceae. In pursuit of an ideal to maintain this *Lewia* spp./*Alternaria infectoria* species-group relationship in a morphologically tenable, presumably monophyletic line, two *Lewia* taxa and ascospore-derived isolates of their *Alternaria* anamorphs are presented as novel.

### 305. *Lewia viburni* E. G. Simmons & McKemy, sp. nov.

Fig. 219

*Ascomata subglobosa ca. 250µm diam., parietibus tenuibus, brunnea, apice rostellata. Asci subcylindrici, recti vel submusiformes, 8-spori (nonnumquam 4-6), 95-120 x 15-18µm. Ascosporae juventute fusoideae vel anguste ellipsoideae, aequilaterae vel inaequilaterae; maturitate ellipsoideae, dilute fulvae, 5(-6) transeptatae et in 4 segmentis mediis transversis 1-2 longiseptatae, 18-20 x 7-8µm. Habitatio typi in caule Viburnum sp., specimen ex vel via The Netherlands ab USDA-APHIS intercepta. Holotypus BPI 841914, ascomata in lamina vitrea ex APHIS Chicago 021414, ver 2001 intercepta (EGS 49-147).*

At least two APHIS intercepts bore ascomata of *L. viburni*; both yielded identical *Alternaria* anamorphs from isolated ascospores (BPI 747305 and BPI 841914 (EGS 49-098 and EGS 49-147). Ascomata of *L. viburni* develop within the host cortex and lie beneath or are barely erumpent through the epidermis. They are subglobose with a short perforate beak, ca. 250µm diam., medium brown, thin-walled. Asci are subcylindrical, straight to submusiform (depending on proximity to ascoma-wall curvature), max. ca. 95-120 x 15-18µm, usually 8-spored but often with only 4 or 6 ascospores.

Juvenile ascospores are fusoid or narrowly ellipsoid, equilateral in one view and inequilateral when seen at a 90° turn on their long axis, 1-3 transeptate (4-segmented) while still subhyaline, and soon with one longiseptum in each of the two central segments. One transeptum is added through each central segment, yielding the 5-septate condition of mature ascospores. (A sixth transverse septum occurs rarely.) A second longitudinal septum often is added to all central segments of the ascospore. The terminal segments of the ascospore usually remain aseptate, although largest individuals sometimes have a single longiseptum. The majority of fully developed ascospores are ellipsoid with the distal cell more broadly rounded than the basal segment, ca. 18-20 x 7-8µm, and have a strong median constriction and weaker constrictions at other transepta. A few ascospores in each ascoma are obviously longer than those of the general population, becoming broadly oblong in outline and up to ca. 22-23µm long. This exceptional ascospore size may represent nothing more than pregermination swelling; it appears to a minor extent among hundreds of ascospores with a smaller size range. Ascospore color is a dilute tawny brown; septa are slightly darker.

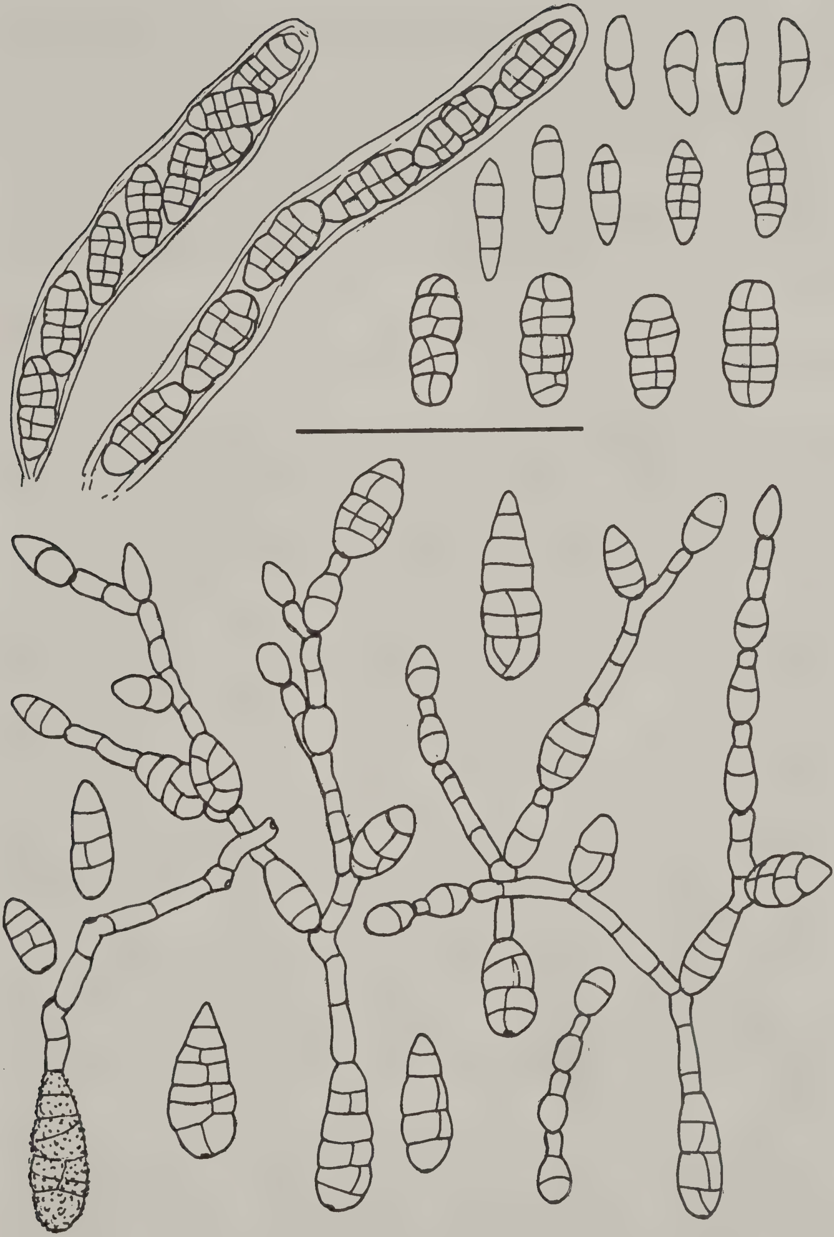

Fig. 219. *Lewia viburni* asci and ascospores (above bar); *Alternaria viburni* conidia and secondary conidiophores, representing minor portions of sporulation clusters.
EGS 49-147. Bar = 50μm.

As is found in ascospores of other *Lewia* species, the median transeptum locus in juvenile ascospores remains subhyaline while other septa begin to acquire color. A pigmented septum eventually forms across the median, but the ascospore outer wall—already formed and pigmented—frequently separates at its ring of juncture with this median septum. As noted for some species of *Pleospora* (Simmons 2001), juvenile ascospores of *L. viburni* sometimes are longer than fully developed ascospores in the same ascoma; the plastic ends of juvenile ascospores are pulled inward as the ascospore widens in maturity.

Anamorphosis: ***Alternaria viburni*** E. G. Simmons, sp. nov.
Fig. 219

*Ex ascosporis holotypi Lewia viburni cultis in agaro PCA descripta. Coloniae mycelio epiagaro et aerio arachnoideo vel laxe byssoideo, variabile sparsim v. moderate v. copiose conidiogenae. Sporulatio in fasciculis dumosis, catenis ramosissimis. Conidia ovoidea vel subellipsoidea, erostratae, ad 25-32 x 8-10(-13)µm, dilute fulva, punctata, ad 6-7 transverse et 1 longitudinaliter septata, conspicue pseudorostratescentia. Conidiophora secundaria (pseudorostra) catenarum conidiorum valida, in 1-4 locis valde geniculata et conidiogena. Typus: partes ex cultura EGS 49-147 (ex ascosporis holotypi Lewia viburni in caule Viburnum sp.) desiccatae et in BPI 841915 (Holotypus) et saltem IMI (isotypus) conservandae.*

Young colonies of *A. viburni* (3-4 d. in PCA plates) are arachnoid to loosely cottony with sparse sporulation on the aerial hyphae. Older colonies retain an open texture, with small clusters of branching chains arising on nearly all hyphal elements of the aerial mycelium. Similar small clusters arise from spreading surface hyphae; many such clusters develop further into dense, bushy populations of several hundred conidia. The sporulation clumps, although produced in large numbers, are distinct enough from each other that, to the unaided eye, they give the colony a granular appearance.

Conidia are ovoid to subellipsoid and erostrate. The initial conidia formed on primary conidiophores are ca. 25-32 x 8-10(-13)µm, dilute tawny brown, punctate-roughened, with up to 6-7 transepta and 1 longiseptum in several of the transverse segments. The primary conidium produces a distal secondary conidiophore that typically is sturdy and strongly geniculate and conidiogenous at several (1-4+) well-separated loci. Each conidiogenous locus supports secondary sporulation that may be a single conidium or, more commonly, a further development of short chains of smooth or punctate conidia separated by sturdy, geniculate secondary conidiophores. Conidia in the developing sporulation head are smaller than the primary conidia, with many spores in distal chains having as few as one or two cells plus their apical conidiophore extensions. The sporulation pattern of *A. viburni* is unusual in that the scaffold of sturdy secondary conidiophores is more striking and diagnostic than are the characteristics of the conidia themselves.

### 306. *Lewia intercepta* E. G. Simmons & McKemy, sp. nov.
Fig. 220

*Ascomata subglobosa ca. 250µm diam., parietibus tenuibus, brunnea, apice rostellata. Asci cylindrici, recti vel submusiformes, plerumque 8-spori, 110-140 x 11-13µm. Ascosporae juventute ellipsoideae, aequilaterae vel inaequilaterae; deinde late subellipsoideae ad septum medianum fortiter constrictae, semispora subsphaerica; maturitate oblongae, minime constrictae, dilute fulvae, transverse 5 et longitudinaliter 1 septatae, 19-22(-25) x 8-10(-12)µm. Habitatio typi in caule Viburnum sp., specimen ex vel via Netherlands ad USDA-APHIS intercepta. Holotypus BPI 841916, APHIS Chicago 021385, ver 2001 intercepta (EGS 49-137).*

Ascomata of *L. intercepta* develop within the host cortex and lie beneath or are barely erumpent through the epidermis. They are subglobose, ca. 250µm diam., and have a short perforate beak that is slightly darker than the thin, medium brown ascoma wall. Asci are cylindrical, straight to submusiform, max. ca. 110-140 x 11-13µm, usually 8-spored.

Juvenile ascospores are ellipsoid and equilateral in one view but strongly inequilateral when seen at a 90° turn, 1-3 transeptate (4-segmented) while still subhyaline and soon with a single longiseptum in each of the two central segments. One transeptum is added through each central segment, yielding the typical 5-septate condition of mature ascospores. (A few ascospores in each centrum have a sixth transeptum.) A single longiseptum usually is inserted in the terminal segments of the largest ascospores.

Typically and diagnostically, ascospores of *L. intercepta* develop from the juvenile narrow-ellipsoid stage into an intermediate broadly subellipsoid condition in which the ascospore is so strongly constricted at the median septum that each half appears to be almost spherical. Further enlargement yields oblong ascospores with broadly rounded ends and only minor constriction at transepta; max. size is ca. 19-22(-25) x 8-10(-12)μm, color dilute tawny brown.

Anamorphosis: ***Alternaria intercepta*** E. G. Simmons, sp. nov.
Fig. 220

*Ex ascosporis holotypi Lewia intercepta cultis in agaro PCA descripta. Coloniae mycelio epiagaro et aerio arachnoideo vel laxe byssoideo, variabile sparsim v. moderate v. copiose conidiogenae. Conidia ovoidea, erostrata, ad 25-28 x 8-10μm, dilute fulva, laevia vel punctata, ad 6-7 transverse et 1 longitudinaliter septata. Conidiophora secundaria (pseudorostra) interdum ad 20-50 x 3-4μm, in 2-5 locis geniculata et conidiogena, autem plerumque unicellularia ca. 3 x 4μm. Typus: partes ex cultura EGS 49-137 (ex ascosporis holotypi Lewia intercepta in caule Viburnum sp.) desiccatae et in BPI 841917 (Holotypus) et saltem IMI (isotypus) conservandae.*

Young colonies (3-4 d. on PCA) are arachnoid to loosely cottony and practically devoid of sporulation. Colonies retain an open texture as they age and begin to produce loose clumps of branching chains of conidia. Within 7-10 days nearly all aerial hyphae have produced clusters of sporulation, as have the spreading surface hyphae. Individual clusters of chains have a diverging branching appearance rather than that of a dense clump of conidia; clusters are spaced in such a fashion that the colony has a granular appearance when viewed without magnification. Longest chains in a cluster have 10-15 conidia; individual clusters have a few dozen to a few hundred conidia.

Conidia are ovoid and erostrate, never with a beak portion distinguishable from the spore body. Conidium size reaches a range of 25-28 x 8-10μm; most conidia are smaller, with great numbers of them in the longer chains consisting of only one or two cells plus a distal secondary conidiophore. Conidium color is a dilute tan; outer walls are smooth to punctate. Conidia have up to 6-7 transepta and 1 longiseptum in the wider segments of most conidia. Although exceptionally long or unusually multigeniculate secondary conidiophores are present in some position in most conidial chains of *A. intercepta*, they do not dominate the structure of the branching sporulation apparatus (in contrast to the pattern in *A. viburni*). Typically, each exceptional secondary conidiophore is at least as long or commonly 2-3 times as long as the conidium that produced it; it usually is geniculate and conidiogenous at 2-5 loci along its length. All other conidia (except terminal ones in the branching chains) bear a simple 1-cell apical conidiophore.

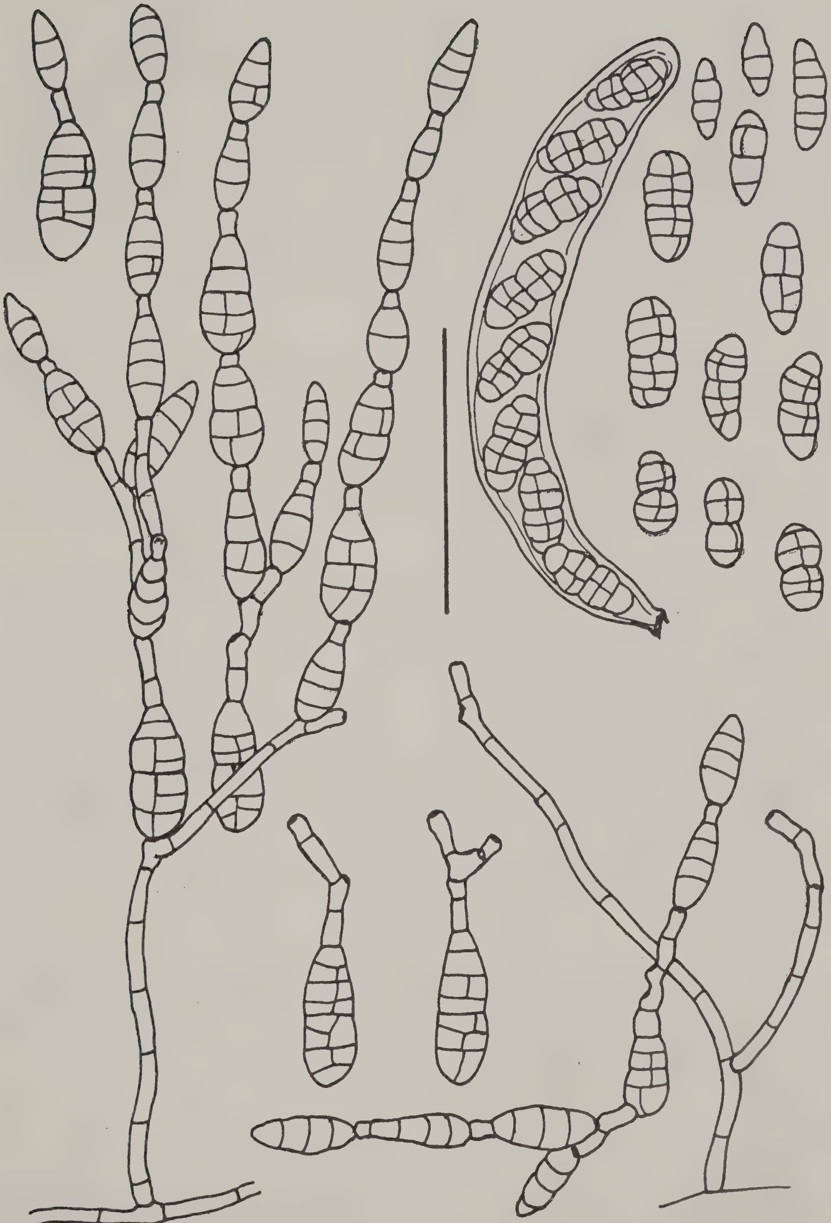

Fig. 220. *Lewia intercepta* ascus and ascospores (right of bar); *Alternaria intercepta* conidia and conidiophores, representing minor portions of sporulation clusters.
EGS 49-137. Bar = 50$\mu$m.

## 307—309. New taxa: Alternaria infectoria species-group

The concept of an *Alternaria infectoria* species-group encompasses several taxa that share a few morphologic characteristics which, for diagnostic purposes, dissociate them, along with *A. infectoria*, from other groups of small-spored *Alternaria*. The group is related to a proposal of M. E. Barr and E. Simmons (Simmons 1986) to recognize a genus *Lewia* for some simple phaeodictyosporous ascomycetes that fit poorly in the morphologic heterogeny of classical *Pleospora* and that produce *Alternaria* anamorphs, at least in culture.

Anamorphs of this group have, in common, attributes of wooly and arachnoid mycelial growth that tends to become patchy and tufted as the colony develops and ages on PCA; small to massive clusters of branching chains of conidia; and, to varying degrees, secondary conidiophores that are strikingly longer than conidia that produce them. Conidia of group members have no definable beak other than the pseudorostra they may generate during chain production.

The colony morphology and sporulation pattern permit group recognition. And, as indicated in the introductory remarks, the species-group appears to be retaining its identity in gene-based and secondary-metabolite studies.

Fairly large numbers of isolates for the group have been coming to my attention from numerous substrates and habitats for years. I am confident that scores of early isolates in my own collection were simply filed away, unstudied, because the somewhat patchy appearance of colony development and sporulation gave an impression of "unstable growth"—an impression that has lost its force following adoption of a standard set of culture conditions.

With or without a *Lewia* teleomorph, *Alternaria* taxa of the *A. infectoria* species-group are recognizable. Three isolates accessioned recently are used here as the bases for descriptions of three new anamorph taxa.

### 307. **Alternaria merytae** E. G. Simmons, sp. nov. Fig. 221

*Ex culturis in agaro PCA descripta. Coloniae mycelio subhyalino arachnoideo vel laxe lanuginoso, cito abunde conidiogenae. Sporulatio in fasciculis dumosis et congestis, catenis ramosissimis. Conidiophora primaria ad ca. 100-250 x 2.5-4.0µm, in 3-6 locis geniculata et conidiogena. Conidia primaria anguste ellipsoidea, 25-40 x 6-8µm, dilute brunnea, 3-7 transeptata. Conidiophora secundaria ad 50-120 x 2.5-*

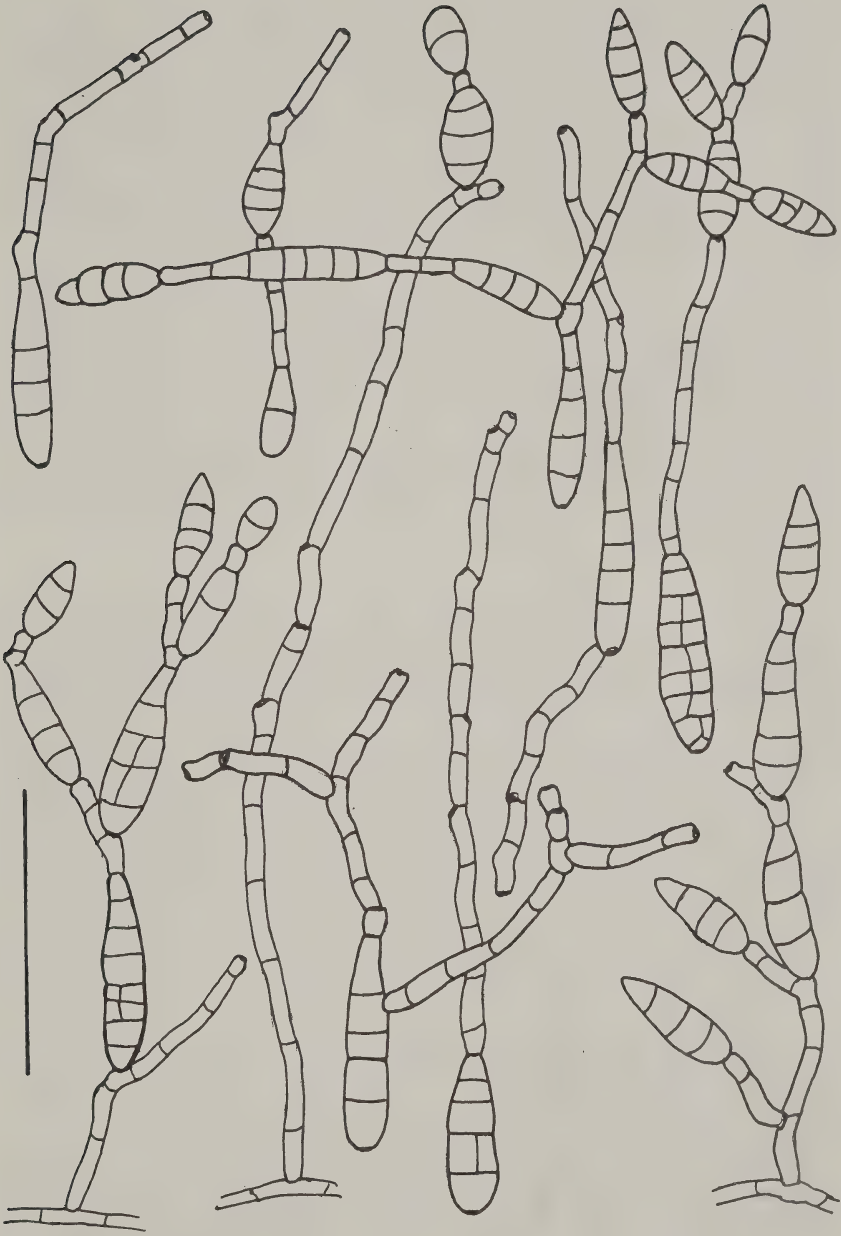

Fig. 221. *Alternaria merytae* conidia and primary and secondary conidiophores, representing portions of sporulation clusters. EGS 46-153. Bar = 50μm.

*4.0µm, in 3-5 locis geniculata et conidiogena. Conidia secundaria ellipsoidea vel ovoidea, 12-20 x 5-8µm, dilute brunnea, laevia, transverse 1-4 septata, raro 1-longiseptata in segmento uno transverso. Habitatio typi in folio Meryta sinclairii Seem., Whitford, South Auckland, New Zealand. Typus: partes ex cultura EGS 46-153 ex folio Meryta sinclairii Seem., lect. et sejunct. C. F. Hill, iii.1998, Whitford, South Auckland, New Zealand (Lynfield no. 16300) desiccatae et in* ***BPI*** *841918 (Holotypus) et saltem* ***IMI*** *(isotypus) conservandae.*

Young colonies of *A. merytae* are subhyaline and arachnoid to loosely wooly; abundant sporulation already is present on both surface and aerial hyphae at 3d. on PCA. Early and abundant production of crowded branching chains makes it difficult to visualize the three-dimensional sporulation pattern—and almost impossible to draw or photograph it. Nevertheless, basic elements of the sporulation apparatus are distinctive enough to permit a diagnostic approach to the taxon as a member of the *Alternaria infectoria* species-group.

In a 7-day-old colony, densely crowded sporulation clumps occur on the agar surface in concentric rings that are prominent at the successive 1-4d. positions of colony-margin advancement. Each of these dense clumps contains hundreds of conidia. The clump develops from one or a few neighboring primary conidiophores, each of which may renew geniculate growth and conidium production at 4-5 sites. The conidium population then increases almost exponentially as each of the few primary conidia produces one or more secondary conidiophores, which themselves become multigeniculate and conidiogenous. With additional secondary conidiophores or short branching chains of conidia developing at each geniculate site, the few original primary conidia of a cluster manage, through a few successive generations, to yield a dense population of hundreds of spores.

All hyphae of the colony are fertile, but the sporulation pattern simplifies as surface hyphae and the arachnoid aerial elements spread beyond and above the dense surface clumps. Each of the simpler clusters is basically a relatively short primary conidiophore that becomes conidiogenous at only 1-3 sites, with each site supporting a much reduced progeny of a few conidia in simple chains or up to ca. 10-40 conidia in a few branching chains. Secondary conidiophores of exceptional length are striking components of the denser surface clusters; similar but shorter sporogenous elements are found within most of the simple aerial spore clusters.

Primary conidiophores vary in size up to a range of ca. 100-250 x 2.5-4.0μm and may have 3-6 secondary growth extensions and related conidiogenous sites. Very similar secondary conidiophores may reach a size range of 50-120 x 2.5-4.0μm and have 3-5 extensions and conidiogenous sites. Conidiophores usually are simple, although branching may occur. Primary conidia in sporulation clumps tend to be narrowly elliptical before secondary conidiophores form, 25-40 x 6-8μm, subhyaline to dilute tan, smooth to punctulate, and 3-7 transeptate, without longitudinal septa or sometimes with one longiseptum in 1-2(-6) of the transverse segments. Secondary conidia in a rapidly developing cluster may have only 1-3 cells when generation of an apical conidiophore begins. Later generations of conidia in the short terminal chains of a cluster are ellipsoid or ovoid, 12-20 x 5-8μm, very pale tan, smooth, 1-4 transeptate, rarely with a single longiseptum in one transverse segment. These small conidia are the dominant but non-diagnostic component of the population, far outnumbering the more conspicuous conidiophore-generating spores that produce them.

### 308. **Alternaria humuli** E. G. Simmons, sp. nov. Fig. 222

*Ex culturis in agaro PCA descripta. Coloniae mycelio subhyalino arachnoideo vel laxe lanuginoso, cito abunde conidiogenae. Sporulatio in fasciculis distinctis, ramis diffusis. Conidiophora primaria simplicia, plerumque 40-50 x 3-4μm, in 1-3 locis geniculata, vel ramosa ad ca. 125μm long., in 8-10 locis geniculata et conidiogena. Conidia primaria ellipsoidea vel ovoidea, 28-38 x 10-11μm, sordide dilute brunnea, laevia, 5-8 transverse et 0-1 longitudinaliter septata, conidiophoris secundariis 20-50 x 3-4μm. Conidia secundaria vulgo ellipsoidea vel late ovoidea, 19-26 x 10-13μm, 3-4 transverse et 1 longitudinaliter septata. Habitatio typi in folio Humulus lupulus L., prope Strasbourg, Alsace, France. Typus: partes ex cultura EGS 47-140 ex folio Humulus lupulus, lect. et sejunct. J. M. Jetsch, xxii. IX.1998 (IMI 379808) desiccatae et in BPI 841919 (Holotypus) et saltem IMI (isotypus) conservandae.*

Young colonies of *A. humuli* are subhyaline and arachnoid to loosely wooly; abundant sporulation already is present on both surface and aerial hyphae at 3 d. on PCA. In a 7-day-old colony, clusters of sporulation crowd the agar surface, but they do not develop into the kind of dense conidial clumps that are characteristic of *A. merytae*. Instead, each cluster is distinguishable as a simple to modestly branching development of primary conidiophores with an apical, rather open system of a few branching chains of conidia. The colony shows moderate evidence of concentric rings of sporulation. The denser rings represent areas of sporulation in which the conidial clusters are semi-arborescent, being taller and more branched than the smaller clusters that make up the major portion of the colony. Arachnoid aerial hyphae are present and conidiogenous above the entire colony, but sporulation clusters are scattered and composed of only 2-10 conidia in straight or meagerly branched chains.

Primary conidiophores in the surface growth are simple or commonly variously branched. This angled branching establishes the sort of open, divergent appearance characteristic of chain development in *A. humuli*. Primary conidiophores may be only 2-3 cells long, but usually they are 40-50 x 3-4μm and, when branched, up to ca. 125μm long. Primary conidiophores have 1-3 geniculate and conidiogenous sites when unbranched, 8-10 or more when branched.

Single conidial clusters in the surface growth may contain an estimated 100-150 spores following a process of secondary conidiophore extension and branching. More commonly, however, a surface cluster contains ca. 20-40 conidia; terminal chains in a branching cluster have 2-6 conidia. Secondary conidiophores of exceptional length, characteristic of the *A. infectoria* species-group, are present at a few positions in most conidial clusters; they are 20-50 x 3-4μm with 1-3 conidigenous sites, and never reach the extreme lengths found in *A. merytae* (*Alt.T&V* 307). Most of the other secondary conidiophores in the conidial cluster are simple single-cell extensions of the spore body.

Primary conidia often (but not always) are the largest units of a spore cluster; the largest conidia in the sporulation cluster, primary or elsewhere in a chain, are elliptical or ovoid, 28-38 x 10-11μm, dull grey-tan with darker septa, smooth, and 5-8 transeptate without longitudinal septa or with one longiseptum in 1-5 of the transverse segments. These largest conidia usually are the producers of the characteristic secondary conidiophores of exceptional length. Secondary conidia in the cluster may be as large as primaries, but usually they are ellipsoid or broadly ovoid in a size range of ca. 19-26 x 10-13μm, with 3-4 transepta and one longiseptum in 1-3 of the transverse segments.

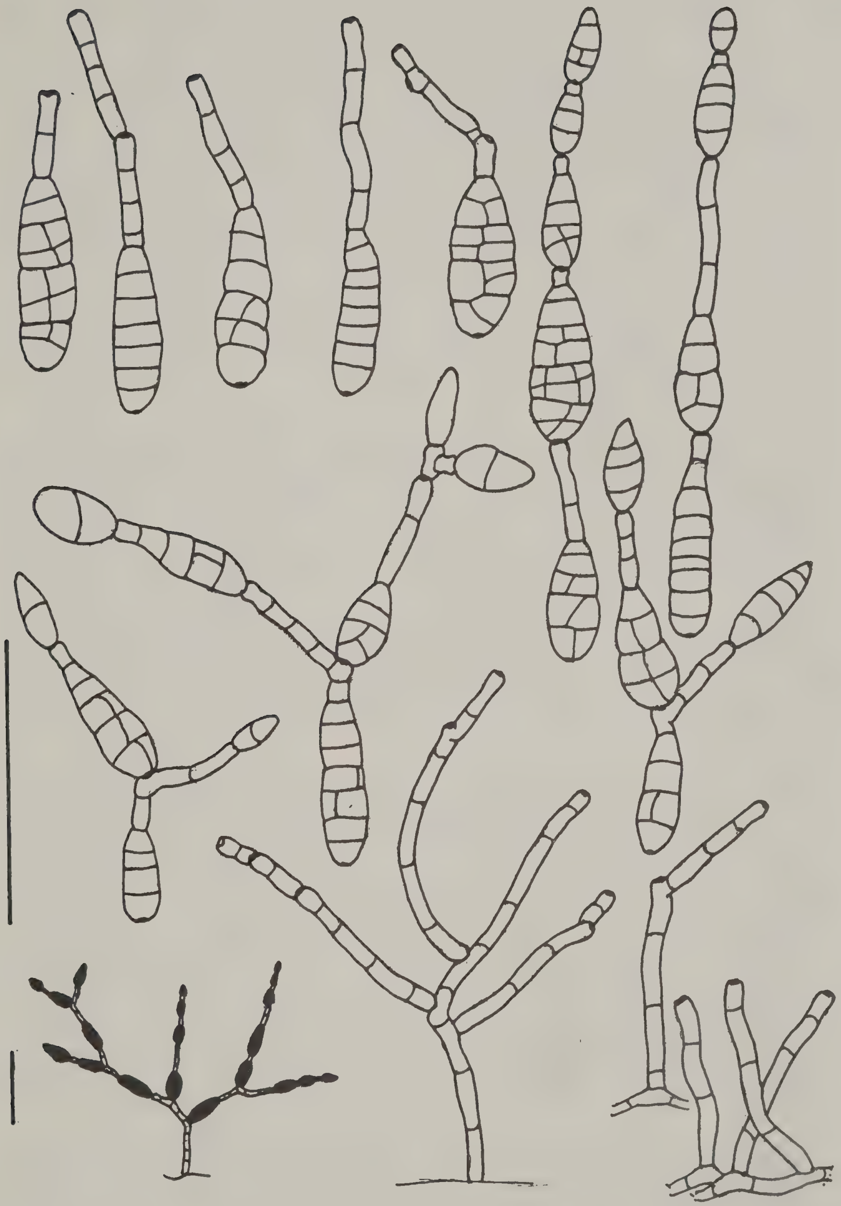

Fig. 222. *Alternaria humuli* conidia and conidiophores, representing minor portions of sporulation clusters; and habit of a relatively small clump. EGS 47-140. Bars = 50μm.

### 309. **Alternaria novae-zelandiae** E. G. Simmons, sp. nov.
Fig. 223

*Ex culturis in agaro PCA descripta. Coloniae mycelio subhyalino arachnoideo vel laxe lanuginoso. Sporulatio in fasciculis congestis sed distinctis, ramis diffusis. Conidiophora primaria simplice vel ramosa, 50-80 x 3-5µm, in 1-3 locis geniculata et conidiogena. Conidia primaria anguste oblonga, ellipsoidea vel ovoidea, ad ca. 28-40 x 8-13µm, dilute vel modice fulva, punctata, 6-10 transverse et 0-1(-2) longitudinaliter septata. Habitatio typi in folio Daucus carota L., Lincoln, New Zealand. Typus: partes ex cultura EGS 48-092 ex folio Daucus carota, lect. et sejunct. M. Braithwaite 300/81, Lincoln, New Zealand (Lynfield 116B) desiccatae et in* **BPI** *841920 (Holotypus) et saltem* **IMI** *(isotypus) conservandae.*

Young colonies of *A. novae-zelandiae* are subhyaline and arachnoid to loosely wooly; clusters of a few conidia (up to 10-15) already are scattered on aerial hyphae above the center of the colony at 2 d. on PCA. By 3 d. and subsequently, discrete but crowded clusters of openly branched conidial chains are produced in an even stand over the agar substrate of the entire colony. Dense clumps of sporulation (as seen in *A. merytae*) are not found, and there is only minor evidence of concentric rings of denser sporulation. The initial arachnoid aerial hyphae over the center of the colony do not develop conspicuously over the entire colony.

Primary conidiophores arising near the agar surface are up to ca. 50-80 x 3-5µm in size, usually are simple or occasionally branched, and incorporate 1-3 conidiogenous sites. Single conidial clusters in this surface growth may contain an estimated 300-400 spores. More commonly, however, a surface cluster arising from a single primary conidiophore contains ca. 30-50(-100+) conidia. Terminal chains in a branching cluster have 2-10 conidia. Secondary conidiophores of unusual length (2-3 times spore-body length) are not as common features of *A. novae-zelandiae* sporulation as they are of the other taxa discussed here. Instead, the branching structure of the cluster depends largely on only moderately long (ca. 30µm), 1-3-geniculate secondary conidiophores.

A few primary conidia produced during early rapid growth of the colony bear secondary conidiophores as long as ca. 60µm; these and the abundant geniculate, intercalary conidiophores represent the *A. infectoria* species-group character of conspicuous secondary-conidiophore development. Essentially all other secondary conidiophores within the conidial cluster are short 1-2-celled extensions of the spore

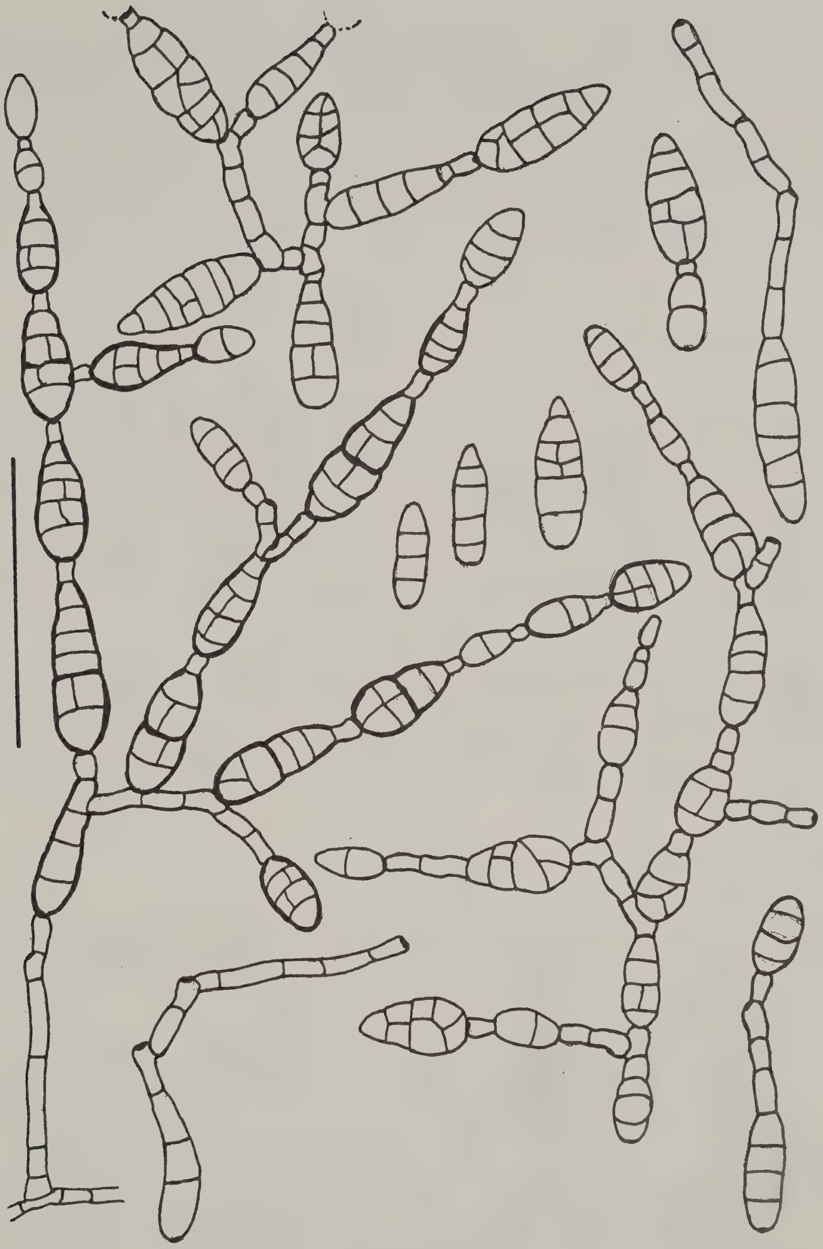

Fig. 223. *Alternaria novae-zelandiae* conidia and conidiophores, representing minor portions of sporulation clusters. EGS 48-092. Bar = 50μm.

body. Conidia of *A. novae-zelandiae* are narrowly oblong, ellipsoid or ovoid with a rounded apex that has no definable beak portion before extension into a secondary conidiophore. Initial conidia tend to be narrowly oblong; most others are ellipsoid and ovoid, up to ca. 28-40 x 8-13μm, dilute to medium tawny brown, conspicuously punctate, and 6-10 transeptate, without longisepta in narrow-oblong conidia or with 1(-2) longitudinal septa in some of the transverse segments of broader conidia.

## ACKNOWLEDGEMENTS

Colleagues Drs. John M. McKemy and Mary E. Palm (APHIS, USDA, Beltsville, Maryland) have been generous in allowing me to study specimens of *Lewia* material on *Viburnum* that have come to their attention. Isolates from the material have permitted renewed study and confirmation of the *Lewia/Alternaria infectoria* species-group relationship. In addition, Dr. Palm is thanked for her critical review of the manuscript preliminary to its submission for publication.

The input of Dr. John David (International Mycological Institute, CABI, UK) and Dr. C. Frank Hill (National Plant Pest Reference Laboratory, MAF, Auckland, NZ) also is acknowledged, with thanks for isolates of *Alternaria infectoria* species-group anamorphs that have proved taxonomically novel in the present study.

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# MYCOFLORA OF PISTACIA VERA IN THE CENTRAL VALLEY, CALIFORNIA

**WEI-QUN CHEN[1,2], NEPHTALI NTAHIMPERA[1], DAVE P. MORGAN[1], THEMIS J. MICHAILIDES[1]**

**[1]Department of Plant Pathology, Kearney Agricultural Center, University of California, 9240 S. Riverbend Avenue, Parlier, CA 93648**
**[2]Department of Plant Protection, Northwest Sci-Tech University of Agriculture and Forestry, Yangling, Shaanxi, China 712100**

**ABSTRACT** Samples of leaves, buds, fruits, and fruit clusters of pistachio (*Pistacia vera*) were collected during the middle crop season from different localities in the Central Valley, California. Washings of the plant samples were sprayed on acidified potato dextrose agar (APDA), and fungal isolates were made by transfering them to PDA plates. Twenty six genera, representing fifty six fungal species, including four ascomycetes, one basidiomycete, 48 mitosporic fungi, two zygomycetes, and one yeast, were recovered from both leaf and fruit cluster washings and surface sterilized tissues. Forty four fungi are recorded for the first time from pistachio in the world. A new species of *Exserohilum*, *E. parlierensis* sp. nov., is described and illustrated. Its affinity to closely related species in the same genus is discussed to show the distinguishing morphological features.

**KEY WORDS** pistachio, *Exserohilum parlierensis*, new species

## INTRODUCTION

*Pistacia vera* L. has been cultivated commercially since the early 1980s in California, and production in the Central Valley has expanded rapidly. Presently, the pistachio industry comprises over 30,000 bearing hectares and produces an annual crop valued at over $ 160 million (California Pistachio Commission, 2000). However, very little is known about the mycoflora

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Corresponding authors: W. Q. Chen and T. J. Michailides, E-mail addresses: wqchen@uckac.edu and themis@uckac.edu

associated with *Pistacia vera* and their potential beneficial or detrimental effect on this host, except for a few plant pathogenic fungi, such as *Botryosphaeria dothidea* (Michailides et al. 1992), and *Alternaria alternata* (Michailides et al., 1998). Michailides and Morgan (1990) reported the seasonal changes of mycoflora of pistachio fruits in commercial orchards with different systems of irrigation. A set of control measures towards Botryosphaeria blight and Alternaria late blight was proposed and has been proved useful (Michailides et al., 2000a, Michailides et al., 2000b). However, the drawback of these measures is obvious, as they are highly fungicide oriented which is far from environment friendly and sustainable. In order to develop a sustainable and environmentally sound integrated pest management program, it is important to have a sound understanding of biotic relationships that are beneficial or disadvantageous to the crop. The objective of this study was to identify and quantify fungi in asymptomatic tissue from pistachio grown in the orchard, and determine the species composition.

## MATERIALS AND METHODS

Three samples of 16 fruit clusters and 16 leaves from either male or female trees were randomly collected from each of three orchards: orchard S, San Joaquin County; orchard Y, Yolo County; orchard G, Glenn County. Four leaves from each orchard were washed for 2 hours in a plastic bottle containing 50 ml of sterile distilled water. Four fruit clusters were washed in bottles containing 20 ml of sterile distilled water. Washing was done by shaking the bottles vigorously for 2 hours at 180 rpm on a two-speed shaker (Eberbach Corporation, Ann Arbor, MI). Four bottles were used for each orchard/plant part combination. After shaking, 0.1 ml of the washing suspension was spread onto the surface of five replicate Petri dishes containing acidified potato dextrose agar (APDA, 2.5 ml of a 25% solution of lactic acid per liter of medium). Inoculated plates were incubated at 27 °C and the fungal colonies developed were recorded after 4-7 days incubation. For direct plating, washed leaves and fruit clusters were surface sterilized for 5 min in 10 % NaClO. They were allowed to dry on a clean paper towel for 30 minutes in a sterile hood. Ten pieces were sectioned from fruit cluster rachises, leaf petioles, mid ribs, and leaf blades to determine the presence of fungi in the tissue. Section pieces were plated on APDA plates and incubated at 27 °C. After 4-7 days incubation the fungal colonies were recorded. Fungal cultures were also recovered from pruning cuts and washings of leaves collected from an orchard located at the Kearney Agricultural Center, Parlier.

Media used for identification included potato carrot agar (PCA) (Simmons, 1992), Water Agar (WA) with carnation leaves (CLA), and potato dextrose agar (PDA) (Nelson et al., 1983), tap water agar (TWA) plus wheat straw (Sivannesan, 1987). Microscopic morphological characteristics were used to identify each individual isolate recovered. Representative isolates for the most common species were saved from all plant parts and from each orchard. These isolates are stored at 4 °C in grade 40 silica gel (Division Chemical, Baltimore) and are being maintained in the Culture Collection of the Department of Plant Pathology, Kearney Agricultural Center, University of California.

Keys and descriptions in the following publications were used in identification: Simmons (1992, 1993), Domsch and Gams (1980), Ellis (1971, 1976), Nelson et al. (1983), Sutton (1980), Sivanesan (1987).

## RESULTS

Table 1 gives the global list of species isolated. Up to 568 isolates were obtained from the samples, representing 56 species falling into three genera of ascomycetes (four species), 18 genera of hyphomycetes (44 species), two genera of coelomycetes (four species), one genus of basidiomycetes (one species), two genera of zygomycetes (two species) and one yeast. Among the 56 species recovered, 44 are recorded for the first time in the world from *Pistacia vera* L. (French, 1987; Farr et al. 1989), including a new species, *Exerohilum parlierensis*. Facultative parasites or saprophytes are the predominant mycoflora. However, it is not surprising to recover species like *Alternaria* spp. (small spored group), *Botryosphaeria dothidea*, *Botrytis cinerea*, *Phomopsis* spp., which have been reported as pathogens of pistachio, from asymptomatic leaves and fruit clusters, because most of them have been proved to cause latent infections on pistachio. Genera represented by more species include *Fusarium* (10 species), *Aspergillus* (five species), *Alternaria*, and *Trichoderma* (four species each).

Table 1. Fungal species recovered from washings of and surface sterilized *Pistacia vera* leaves and fruit clusters [a]

| Fungal species | Representative isolate | Substrate | Geographic origin |
|---|---|---|---|
| *Acremonium murorum* (Corda) Gams* | CH 5 | fruit cluster | San Joaquin |
| *A. strictum* Gams* | CH 2 | leaf | Fresno |
| *Alternaria alternata* ( Fr.) Keissler | CH 1 | leaf | Fresno |

| | | | |
|---|---|---|---|
| *A. arborescens* Simmons* | CH 6 | leaf | Fresno |
| *A. infectoria* (Fuckel) Barr & Simmons* | CH 8 | leaf | San Joaquin |
| *A. tenuissima* (Nees:Fr.) Wiltshire | CH 17 | leaf | San Joaquin |
| *Aspergillus alliaceus* Thom & Church | CH 20 | fruit cluster | Glenn |
| *A. flavus* Link ex Gray | CH 22 | leaf | San Joaquin |
| *A. fumigatus* Fres. | CH 23 | leaf | Yolo |
| *A. niger* van Tieghem | CH 24 | leaf | Fresno |
| *A. terreus* Thom | CH 25 | fruit cluster | Glenn |
| *Auerobasidium pullulans* (de Bary) Arnaud* | CH 27 | leaf | Fresno |
| *Bipolaris spicifera* (Bainier) Subram. * | CH 3 | fruit cluster | Glenn |
| *Botryosphaeria dothidea* (Moug. Ex Fr.) Ces. & de Not, anamorph *Fusiccocum* sp. | CH 28 | fruit cluster | San Joaquin |
| *Botrytis cinerea* Pers. | CH 29 | leaf | Yolo |
| *Chaetomium elatum* Kunze ex Steud* | CH 52 | leaf | San Joaquin |
| *C. fumicola* Cooke* | CH 31 | leaf | Glenn |
| *Cladosporium herbarum* (Pers.:Fr.) Link* | CH 32 | fruit cluster | Fresno |
| *Curvularia lunata* (Wakk.) Boedijn* | CH 4 | fruit cluster | San Joaquin |
| *C. inaequalis* (Shear) Boedijn* | CH 13 | leaf | Glenn |
| *C. lunata* (Wakk.) Boedijn var. *aeria* (Bat., Lima & Vasconc.) M. B. Ellis* | CH 55 | fruit cluster | Glenn |
| *Epicoccum purpurascens* Link ex Schlecht* | CH 7 | fruit cluster | Glenn |
| *Exserohilum parlierensis* Chen & Michailides* | CH 26 | leaf | Fresno |
| *Fusarium avenaceum* (Fr.) Sacc. * | CH 33 | fruit cluster | Glenn |
| *F. chlamydosporum* Wollenw. & Reinking* | CH 34 | leaf | Glenn |
| *F. culmorum* (Smith) Sacc. * | CH 9 | leaf | Yolo |
| *F. dimerum* Penzig* | CH 11 | leaf | Glenn |

| | | | |
|---|---|---|---|
| *F. equiseti* (Corda) Sacc. * | CH 35 | fruit cluster | Glenn |
| *F. heterosporum* Nees* | CH 36 | leaf | Yolo |
| *F. moniliforme* Sheldon* | CH 10 | leaf | Glenn |
| *F. oxysporum* Schlecht. | CH 37 | fruit cluster | San Joaquin |
| *F. semitectum* Berk.& Rav. * | CH 38 | fruit cluster | Glenn |
| *F. solani* (Martin) Sacc. * | CH 39 | fruit cluster | San Joaquin |
| *Humicola grisea* Traaen* | CH 12 | fruit cluster | San Joaquin |
| *Mucor hiemalis* Wehmer* | CH 40 | leaf | Glenn |
| *Nigrospora sphaerica* (Sacc.) Mason* | CH 54 | fruit cluster | Glenn |
| *Paecilomyces lilacinus* (Thom) Samson* | CH 14 | fruit cluster | Yolo |
| *Paecilomyces variotii* Bain. * | CH 41 | leaf | Glenn |
| *Penicillium chrysogenum* Thom* | CH 16 | leaf | Glenn |
| *P. expansum* (Link) Thom* | CH 15 | fruit cluster | San Joaquin |
| *P. requefortii* Thom * | CH 30 | leaf | Glenn |
| *Phoma glomerata* (Corda) Wollenw. & Hochapfel* | CH 42 | fruit cluster | San Joaquin |
| *P. medicaginis* Malbr. & Roum* | CH 43 | leaf | Glenn |
| *Phomopsis archeri* Sutton* | CH 44 | leaf | Glenn |
| *P. stipata* (Lib.) Sutton* | CH 45 | leaf | Glenn |
| *Rhizopus stolonifer* (Ehrenb:Fr.) Vuill* | CH 46 | fruit cluster | San Joaquin |
| *Schizophyllum commune* Fr. | CH 56 | leaf | Fresno |
| *Sordaria fimicola* (Rob.) Ces. & de Not.* | CH 47 | pruning cut | Fresno |
| *Stemphylium botryosum* Wallr. | CH 18 | leaf | Glenn |
| *Torula herbarum* Pers. Ex Fr. * | CH 19 | fruit cluster | San Joaquin |
| *Trichoderma harzianum* Rifai * | CH 48 | leaf | Yolo |
| *T. koningii* Ouden* | CH 49 | leaf | San Joaquin |
| *T. polysporum* (Link ex Pers.) Rifai* | CH 50 | fruit cluster | Yolo |
| *T. viride* Pers. ex Gray* | CH 51 | fruit cluster | Glenn |

| | | | |
|---|---|---|---|
| *Ulocladium atrum* Preuss* | CH 21 | fruit cluster | San Joaquin |
| *U. chartarum* (Preuss) Simmons* | CH 53 | leaf | Fresno |

[a] Names followed by an asterisk are reported for the first time from *Pistacia vera* (French, 1987; Farr et al. 1989).

Differences in species composition occurred in the orchard among plant parts and among orchards (Table 2). The most common species isolated from orchard S and orchard G were *Alternaria* spp., whereas the most common species from orchard Y were *Aspergillus niger*, *Paecilomyces* spp., and yeast (both white and pink). *Alternaria* spp. was also frequently isolated from orchard Y, but it comprised a lower percentage of the total isolates. The remaining isolates from the three orchards consisted of several species, the most common being *Fusarium* spp. and *Penicillium* spp. *Paecilomyces* spp. was most commonly recovered from fruit clusters from orchard Y.

Table 2. Species composition (percentage) of fungi in washings from leaves of asymptomatic male and female trees and fruit clusters collected from three orchards

| | Orchard S | | | Orchard G | | | Orchard Y | | |
|---|---|---|---|---|---|---|---|---|---|
| Fungal species/genera | ML[a] | FL[b] | FR[c] | ML | FL | FR | ML | FL | FR |
| *Alternaria* spp. | 61 | 55 | 61 | 35 | 55 | 53 | 8 | 15 | 8 |
| *Aspergillus* sp. | <1 | –[d] | – | – | <1 | – | – | <1 | – |
| *A. niger* | 13 | 10 | 3 | 24 | 7 | 4 | 41 | 24 | 20 |
| *Bipolaris* spp. | 4 | 7 | 3 | 5 | – | 1 | – | – | – |
| *Botryosphaeria dothidea* | – | – | 1 | 1 | – | 2 | 1 | – | 3 |
| *Curvularia lunata* | <1 | 3 | 5 | – | 3 | – | – | – | – |
| *Fusarium* spp. | 7 | 12 | 10 | 12 | 5 | – | 1 | 10 | – |
| *Mucor hiemalis* | 3 | 2 | 9 | 1 | 3 | 1 | 2 | – | 2 |
| *Paecilomyces* sp. | – | – | – | – | – | 3 | – | – | 30 |
| *Penicillium* spp. | 5 | 6 | 2 | 6 | 14 | 5 | 5 | 4 | – |
| *Phomopsis* spp | – | – | – | – | 5 | – | – | – | – |
| *Schizophyllum commune* | – | – | – | – | – | 2 | – | 1 | – |
| *Trichoderma* spp. | <1 | <1 | – | 4 | 2 | 5 | 2 | 3 | – |
| Yeast (pink) | – | 4 | 3 | 4 | 2 | 14 | 23 | 10 | 21 |
| Yeast (white) | 2 | – | <1 | 7 | 2 | 7 | 14 | 29 | 11 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| N[e] = | 138 | 166 | 143 | 106 | 115 | 85 | 95 | 113 | 89 |

[a] Leaves collected from male *Pistacia vera* trees.
[b] Leaves collected from female *Pistacia vera* trees.
[c] Fruit clusters of *Pistacia vera*.
[d] – = The fungal species or genera were not recovered.
[e] Total number of isolates recovered.

Description of a new *taxon*.

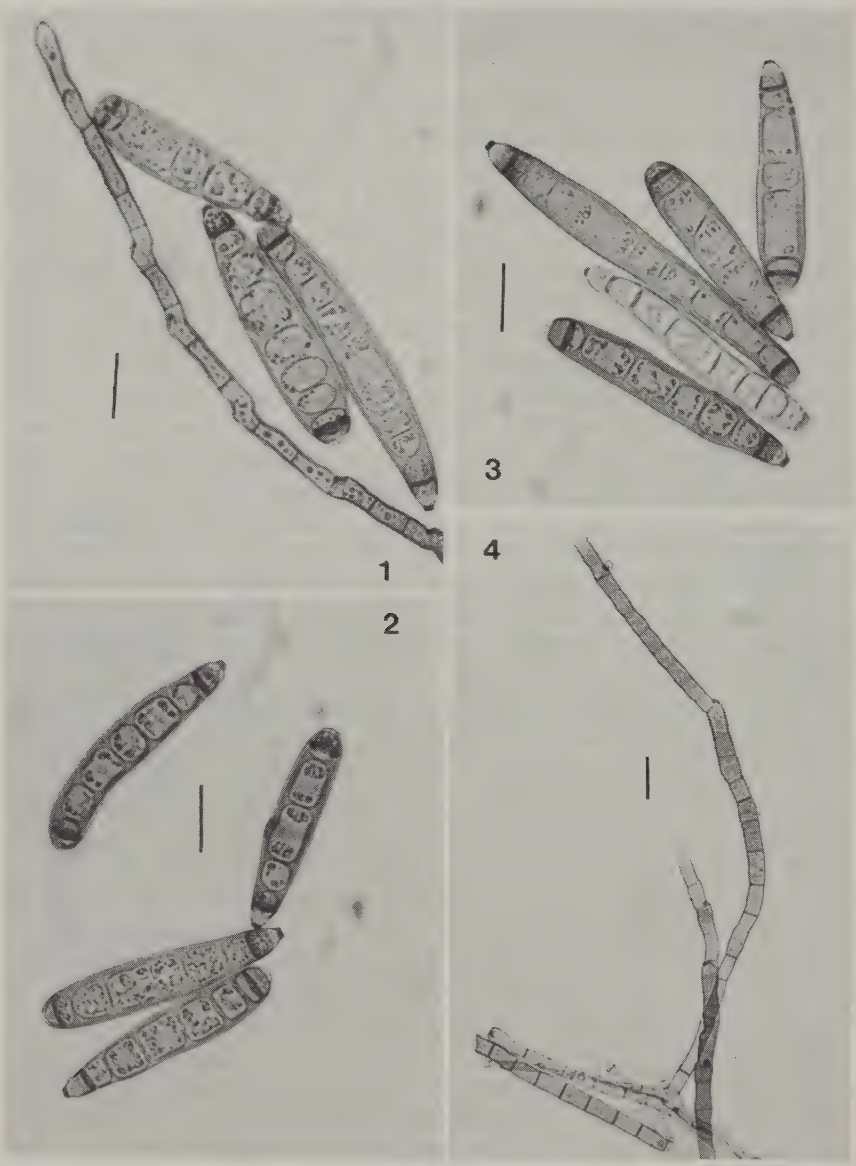
***Exserohilum parlierensis*** W. Q. Chen & T. J. Michailides, sp. nov. Figs 1-4

Etymology: Latin, *parlierensis* = from Parlier, referring to the type locality.

Colonieae in agaro "TWA + wheat straw", velutinae, olivaceobrunneae vel brunneae. Hyphae septate, olivaceobrunneae vel brunneae, leaves. Conidiophora plerumque solitaria, recta vel flexuosa, simplicia, saepe geniculata, pallide brunnea vel brunnea, apicem versus pallidiora, usque 350 µm longa, 4.5-7.5 µm crassa. Cellulae conidiogenae cylindricae, in conidiophores incorporate, terminals et intercalares, polyplasticae, sympodiales, cicatricae. Conidia clavata, leviter attenuata ad basim et rotunda ad apicem, brunnea, laevia, recta, raro curvata, 45-90×10-19 µm, 3-10 distoseptata (plerumque 5-7). Hilo manifesto, 2-3 µm diam. praedita. Germinatio bipolaris.

Colony on PDA effuse, grey, growing rapidly, forming a velvety layer of gray to dark grey mycelia, no sporulation was observed on PDA. Hyphae septate, simple, olivaceous brown to brown, smooth. Conidiophores mostly solitary, straight in the lower sterile section, geniculate toward the apex, pale brown to brown, paler towards the apex, up to 350 µm long, 4.5-7.5 µm thick. Conidiogenous cells cylindrical, integrated, terminal and intercalary, polyblastic, symodial cicatrized. Conidia clavate, rounded at the apex, slightly attenuated to the base, smooth, straight to slightly curved, 45-90×10-19 µm, 3-10 septate (mostly 5-7), basal septum darker and thicker than other septa. Hilum distinctly protuberant, 2-3 µm in diameter. Germination from subhyaline region of the end cells and germ tubs growing semiaxially.

Holotypus: ATCC MYA-2456 (American Type Culture Collection, Manassas, VA 20108), dried culture, isolated from washings of healthy pistachio (*Pistacia vera* L.) leaves, Parlier, California. W. Q. Chen, Aug. 16, 2001, living culture ex-type, CH 26, deposited in the culture collection of the Department of Plant Pathology, Kearney Agriculture Center, University of California, Parlier, California.



Figs 1-4. Conidia and conidiophores of *Exserohilum parlierensis*. Fig. 1, conidia and conidiophore (Bar, 20 µm); Figs 2-3, conidia (Bars, 20 µm); Fig. 4, conidiophores (Bar, 40 µm).

# DISCUSSION

Accurate identification of small-spored *Alternaria* spp. is challenging because of morphological plasticity under non-standard conditions and the common misapplication of the name *A. alternata* to a variety of morphologically distinct taxa (Roberts et al., 2000). There were four species of small-spored *Alternaria* identified in the present work from *Pistacia vera* by not only studying a slide preparation of conidiophores and conidia at high magnifications, but also determining the sporulation pattern (three-dimensional conidiation) of conidia produced by a single conidiophore at moderate (50×) magnifications under consistent conditions as described by Simmons (1992, 1993). Four species would be classified as a single species of *A. alternata* by using the taxonomic criteria of Ellis (Ellis, 1971; Ellis, 1976). The three-dimensional sporulation pattern and the relationship of neighboring conidia are effectively mutilated in any slide preparation, whereas the intact arrangements of conidia chains and branches in stable isolates often exhibit striking heritable differences (Simmons, 1992). Our findings are consistent with Roberts (Roberts et al., 2000) in that when *Alternaria* isolates are cultured and observed under defined conditions, their phenotypic plasticity is minimized and valid taxonomical separations can be made upon morphological characteristics.

Many fungal species isolated from pistachio from the Central Valley have a worldwide distribution, this was already noticed in a previous work (Michailides and Morgan, 1990), and the present results corroborate this investigation. The method used for the isolation of fungal strains did not take into consideration on the status of the fungi (spores, mycelium or resting form), and that some fungi may exist only as resting forms during part of the year. For example, *Fusarium*, *Chaetomium* and zygomycetes produce resistant or resting structures (chlamydospores or ascospores) during a certain period of their life cycles. The survey of mycoflora of pistachio is far from complete. It must be emphasized that it is not possible to accomplish an exhaustive survey of the pistachio mycoflora, due to the different growth rates some species are difficult to isolate, while other species might be unculturable under the conditions used.

Knowledge of plant microflora has greatly facilitated naturally occurring biological control and the introduction of microorganisms for the biological control of plant diseases. An antagonist sought for use in soil, on a plant surface, or within a plant tissue is most likely to develop in that niche if it was originally obtained from a similar niche (Cook and Baker, 1983). The mycoflora of pistachio include quite a few fungi which have been reported having the potential to be used as antagonists to suppress plant pathogenic fungi. Fungal species belonging to *Trichoderma*, *Epicoccum*, *Mucor*, *Ulocladium*, *Aureobasidium pullulans,* and *Paecilomyces* have the potential (Cook and Baker, 1983) to be used as biocontrol agents and therefore warrant further investigation towards the biological control of panicle and shoot blight caused by *B. dothidea*, as well as late blight caused by *Alternaria* spp. Our work also sets the stage for further studies dealing with these fungi, such as the influence of environmental factors (i. e. water and nutritional stress) on fungal frequencies, the influence of agricultural practices on these fungi and thus crop yields, the mechanisms that trigger the latent pathogens to induce symptoms.

The new species of *Exserohilum*, *E. parlierensis* sp. nov., can be readily separated from all other known species of this genus (Alcorn 1988a, 1991; Sivanesan 1987, 1992; Sivanesan et al. 1993; Upadhyay & Mankau 1991; Castaneda Ruiz at al. 1995; Sun et al. 1997; Guiraud et al., 1997; Steiman et al. 2000) mainly on the basis of shape, size and septation of conidia. The closest species are appeared to be *E. rostratum* (Drechesler) K. J. Leonard & Suggs, *E. sodomii* Guiraud, Steiman, Seigle-Murandi & Sage, *E. israeli* Steiman, Guiraud, Seigle-Mur. & Sage. However, *E. parlierensis* differs from *E. rostratum* in both shape and size of the conidia. In *E. rostratum* these tend to be rostrate and much larger (15-200×7-29 µm), whilst in *E. parlierensis* the conidia are most commonly straight or clavate, and never rostrate. Although the size of conidia are similar in *E. israeli* (51-88×12-18 µm) and *E. parlierensis*, the septation in the former mostly (>70%) is 7-10 (Steiman et al. 2000), as compared to 5-7 (>80%) in the latter. *E. parlierensis* can be readily differentiated from *E. sodomii* by the size of the conidia, the conidia of *E. sodomii* are much shorter (41-65µm) (Steiman et al. 2000) as compared to *E. parliensis* (45-90 µm), although septation of the two species is almost the same.

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# GLOMUS SPINOSUM SP. NOV. IN THE GLOMACEAE FROM TAIWAN

Hung-Tao Hu

Department of Forestry, College of Agriculture, National Taiwan University,
106 Taipei, Taiwan, R. O. C.
E-mail: hungtao@ccms.ntu.edu.tw

**Abstract:** *Glomus spinosum* forms yellowish brown to dark red brown spores in sporocarps or single in the soil. The chlamydospores are 40-90μm in diam., and have a 4-10μm thick wall which consists of a thin pale yellow-brown outer wall covered with a hyaline to light yellow dense mass of flexible hairy spines, up to 15 μm long and each up to 3 μm in diameter, a thick dark brown laminated middle wall with warts on the surface, up to 1μm high, and a thin yellowish brown inner wall in one wall group. *Glomus spinosum* forms typical vesicular-arbuscular mycorrhizae with *Cunninghamia lanceolata* and other plant species.

**Key words:** *Cunninghamia lanceolata*, sporocarp, vesicular-arbuscular mycorrhizae.

## INTRODUCTION

During the survey of hypogeous fungi in the rhizosphere of *Cunninghamia lanceolat*a(Lamb.) Hook. spores of a new species of Glomales described here as *Glomus spinosum* were found. The description is based on observation of intact and crushed spores mounted in water, polyvinyl alcohol-lactic acid glycerol (PVLG) and Melzer's reagent examined at 400× with a phase-contrast and bright-field microscope. In addition, observations of spores in scanning electron microscopy were carried out to define the wall characteristics of this new species. For wall terminology, Walker's concept (1983) is followed.

## MATERIALS AND METHODS

Field-collected spores of the here described new species were inoculated to the rhizosphere of one month old non-infected *Allium porrum* L., *A. sativum* L., *Festuca elatior* var. *arundinacea* L. and one-year old *C. lanceolata* seedlings which had been planted in an autoclaved sandy medium. After three months to one year culturing in the glasshouse, chlamydospores were extracted by wet sieving and decanting (Gerdemann and Nicolson, 1963). One hundred wet-sieved spores were examined under the stereomicroscope against white and black backgrounds for color determination. One hundred segments of 1 cm long roots were randomly taken and stained in 0.05% cotton blue to examine the presence of vesicular-arbuscular mycorrhizae (Phillips and Hayman, 1970). At least 300 chlamydospores were cleaned in water and provided for scanning electron microscopic (SEM) observation. For SEM observation, spores and rootlets were fixed in 2.5% glutaraldehyde solution buffered with 0.05M Na-cacodylate at least for one day. The fixed samples were washed with 0.05M Na-cacodylate buffer solution at pH 7.2 four times, each time 15 minutes, dehydrated with a series of aceton from 30% to 100%, post-fixed in 1% $OsO_4$, washed again with 0.05M Na-cacodylate buffer solution four times, dried by critical point dryer using liquid $CO_2$, mounted on an aluminum stub, coated with gold, and then observed under JSM-6300 scanning electron microscope at 20 KV.

## DESCRIPTION

GLOMUS SPINOSUM Hu sp. nov. (Fig.3 and 4)

Sporocarpia irregularia, ad 5 mm, pallide brunneola. Peridium destitutum. Gleba pallide brunnea, cum sporis, hyphis, radicibus, at arena immixta. Chlamydosporae singulae vel laxe gregariae, in solo efformatae, globosae vel subglobosae, 40-90 µm diam. Sporae cortex 4-10 µm crassus. Sporae stratum primum hyalium vel pallide hepaticum, 0.5 µm crassum cum villis ad 15 µm longis, stratum iterum cinnamomeum, porphyreum vel obscure bruneum, vel subfuscum, 3-6 µm crassum, nodulis congestis ornatis, stratum tertium luteo-brunnum, 0.5 µm crassum. Hyphae subtendentes 7-16 µm diam.; formans mycorrhiza cum vesiculis et arbusculis.

SPOROCARPS (Fig. 3 B) pale brown, irregular, up to 5 mm diam. formed by loose interwoven pale yellowish brown hyphae; hyphae consisting of 3 different sizes, (1) 0,5-1.5 µm wide with walls 0.2-0.3 µm thick; (2) 3.6-4.8 µm wide with walls 0.5 µm thick; (3) 5.0-6.0 µm wide with walls 0.5 µm thick; walls yellow with greenish tint, cytoplasm light yellowish; hyphae mostly nonseptate. Peridium absent. Within the sporocarps the spores and hyphae are often intermixed with roots and sand.

CHLAMYDOSPORES formed in sporocarps, or single in soil, or in dead roots, globose to subglobose, 40-90 µm diam. with the majority of spores in the range of 50-70 µm diam.(Fig.1); spores with roughened surface when observed under low magnification power microscope.

SPORE WALL 4-10 µm thick without outer ornamentation. Spore wall (see murograph, Fig. 2) consisting of three wall layers in one group. Wall 1 a hyaline to subhyaline to pale yellow-brown unit wall, about 0.5 µm thick covered with a mass of subhyaline to yellowish hairy protuberances, up to 15 µm long and each 1.5-3 µm in diam. Protuberances often covered on their surface with mucilageous granular-like material (Fig. 4). Wall layer 2, orange-brown, red-brown to dark brown, or nearly black, laminated, 3-6 um thick, ornamented with subhyaline warts, 1.5-3 µm high, 0.7-1.3 µm in diam. which grow into wall 1 (Fig. 4 A). Wall 3 yellowish brown, membranous, 0.5 µm thick. Spore walls do not react with Melzer's reagent.

SUBTENDING HYPHA single, straight or slightly recurved, at the point of spore attachment 7-16 µm wide, with yellowish brown to brown or dark brown wall; wall is continuous of wall layer 2 and generally as thick as the spore wall layer 2 but often unevenly thickened, up to 65 µm from attachment; hyphal attachment wall is not covered with protuberances of wall layer 1. The attachment point of the subtending hypha with the spore is often occluded by the innermost wall layer 3, or by a septum in the subtending hypha in some distance from the attachment point.

FORMS VESICULAR ARBUSCULAR MYCORRHIZAE.

GERMINATION TUBE emerges through the subtending hypha.

ETYMOLOGY: Latin, *spinosus* “spiny”, in reference to the spore wall ornamentation.

DISTRIBUTION AND HABITAT: In the rhizosphere of *C. lanceolata* stands, Nan-Tou county, Taiwan, altitude 700-2000 m. Forming vesicular-arbuscular mycorrhizae with seedlings of *C. lanceolata*, *A. porrum* and *A. sativum* in sand pot culture.

COLLECTION EXAMINED: Type: Nan-Tou county, National Taiwan University Forest, Taiwan, from rhizosphere in the Ah-horizon of *C. lanceolata* stands. 02. Jan. 2000, Hu-0102 (slide); Forest Soil and Mycorrhiza Laboratory, Department of Forestry, National Taiwan University. Holotype: Maintained in pot culture of *C. lanceolata,* Hu 3212(NTU).

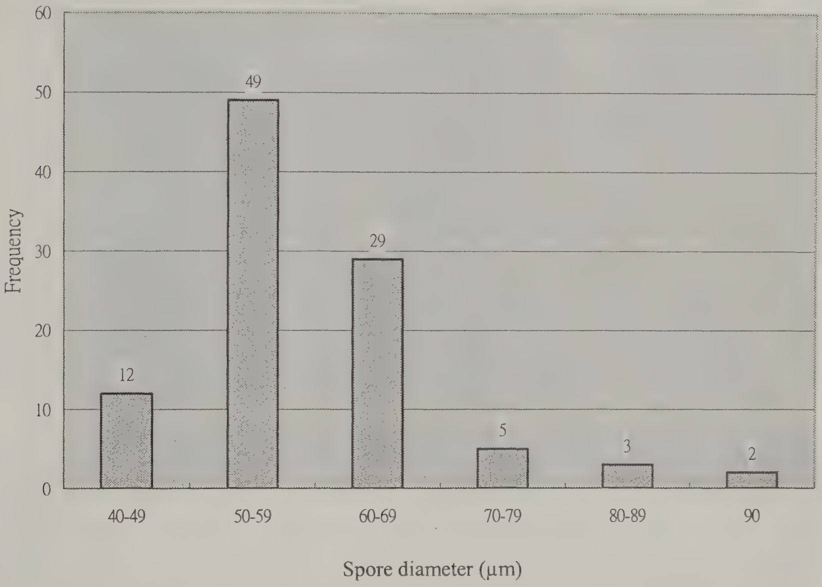

Fig.1 ***Glomus spinosum*** spore diameter frequency from a random selection of 100 mature spores. For non-globose spores, the average diameter of cross and long direction was measured.

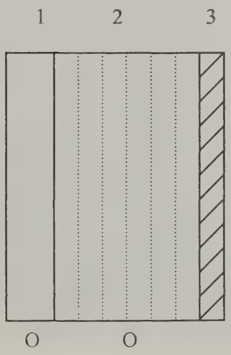

Fig.2. Murograph of *Glomus spinosum.* Spore wall structure (after Walker, 1983) is of three walls in one group. Arabic numerals indicate each wall in order from outer to inner wall; wall 1 and 2 are ornamented, wall 1, 2 and 3 are unit, laminated and membranous, respectively.

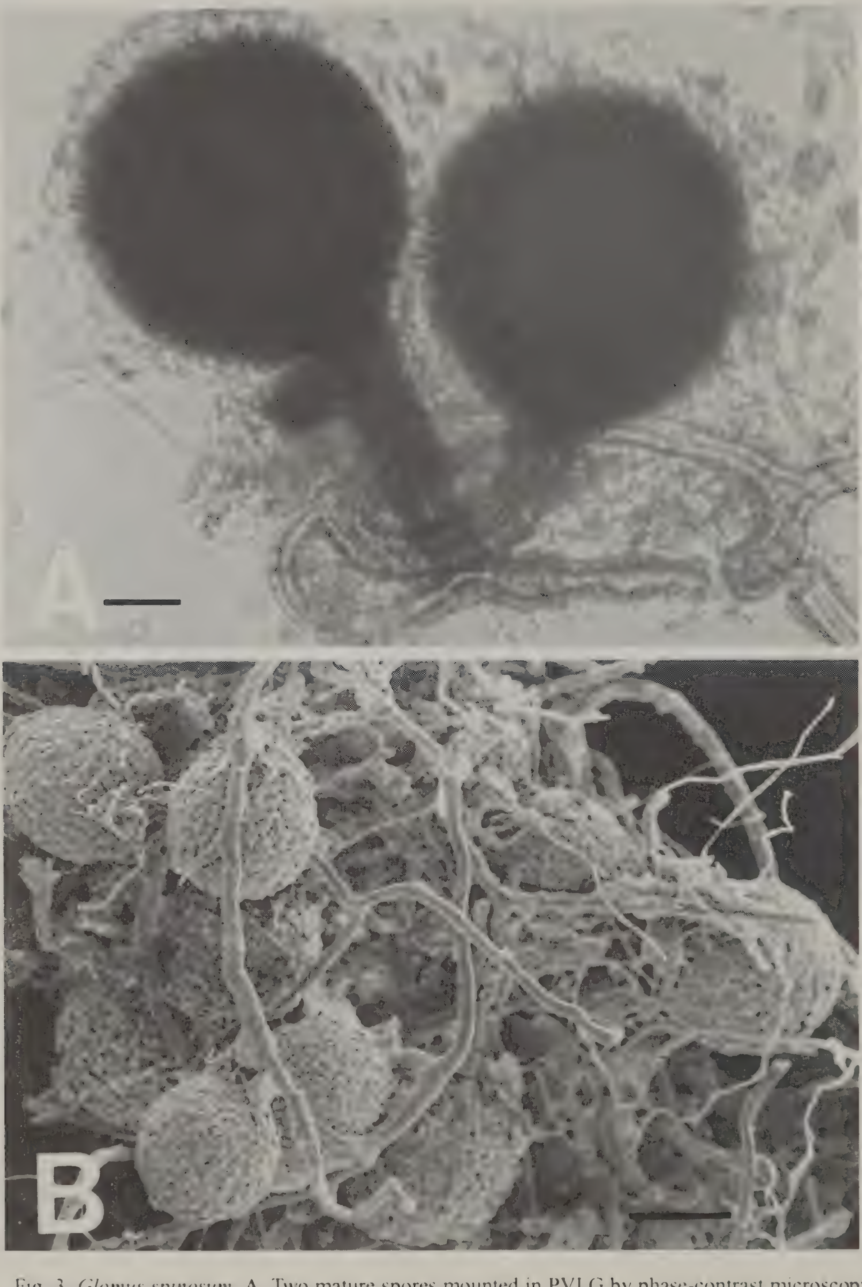

Fig. 3 *Glomus spinosum*. A. Two mature spores mounted in PVLG by phase-contrast microscopy show the spines of wall 2 surrounded by the protuberances of wall 1, bar = 15μm. B. Sporocarp by scanning electron microscopy (SEM), bar = 30μm.

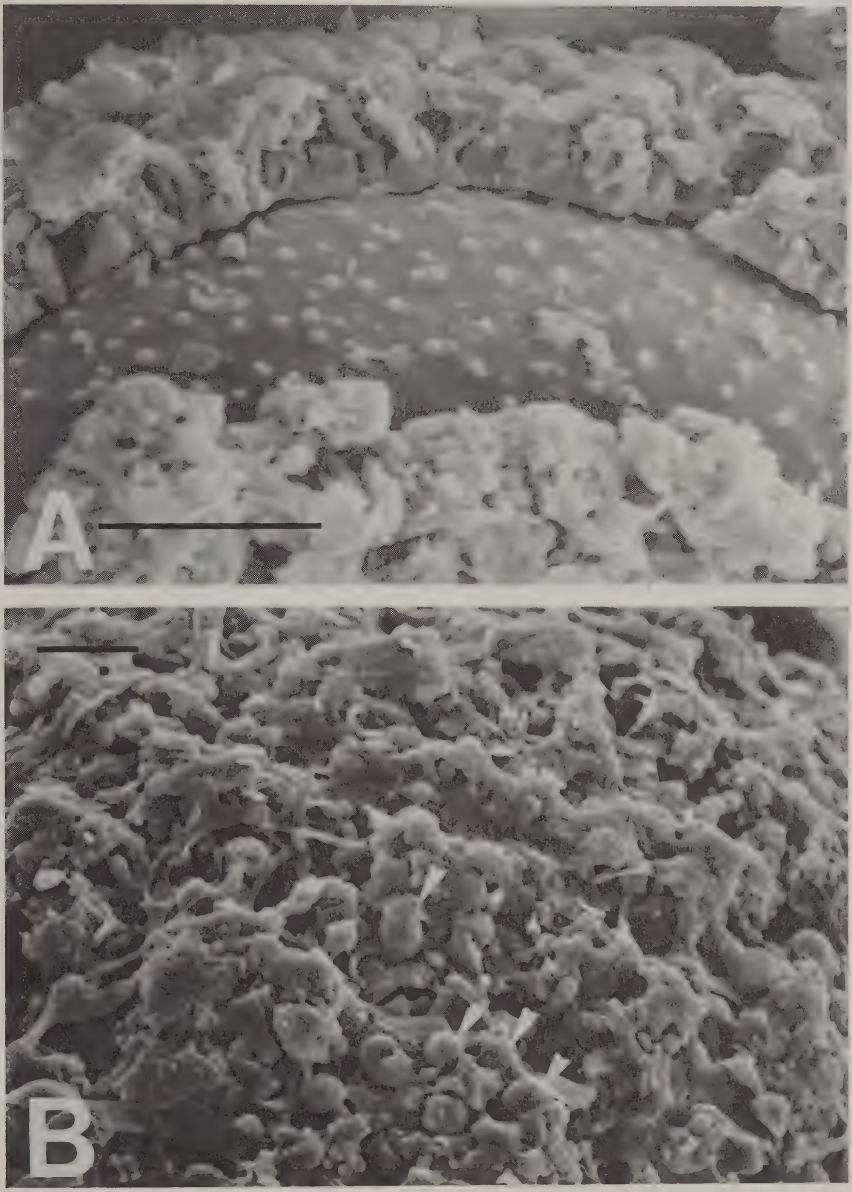

Fig. 4. *Glomus spinosum* A. SEM detail of the crowded protuberances on wall 1 and warts on the outer surface of wall 2, bar= 10 µm. B. SEM detail of the ornamentation shows the muscilageous granular-like material covering the protuberances of wall layer 1 (arrows), bar=5 µm.

## DISCUSSION

*Glomus spinosum* is morphologically easy distinguished from spores of other species in the genus *Glomus* by its dark red brown colored chlamydospores, by having long protuberances on the outer wall, warts on the second spore wall, and by the formation of spores in sporocarps. Spores of *G. spinosum* resemble those of *G. aggregatum* Schenck and Smith (Koske, 1985), when observed under low magnification power stereomicroscope in having similar size or color. However, *G. spinosum* can easily be differentiated from them by the spines when observed at higher magnification. Other ornamented species of the genus *Glomus* are hyaline to subhyaline or are not formed in sporocarps, e.g. *G. scintilans* Rose & Trappe (Rose and Trappe, 1980), *G. chimonobambusae* Wu & Liu (Wu et al., 1995), or *G. veruculosum* (Blaszkowski and Tadych, 1997).

*Glomus spinosum* infected the roots of *C. lanceolata* at high rates with more than 70% infected roots, of *A. porrum* at medium rates (25-30%) and *A. sativum* also at medium rates (30-40%). However, the roots of *F. elatior* var. *arundinacea* were not infected in the greenhouse sand pot culture after inoculation with *G. spinosum*. Hence, it may be that *G. spinosum* is not compatible with all plant species.

## ACKNOWLEDGEMENT

The author gratefully appreciates Dr. E. Sieverding for critically reviewing and correcting the manuscript. This study was partly supported by grant 90-2313-B-002-013 from the National Science Council, Taiwan.

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Gerdemann, J. W., and T. H. Nicolson, 1963. Spores of mycorrhizal *Endogone* species extracted from soil by wet sieving and decanting. Trans. Brit. Mycol. Soc. 46:235-244.

Koske, R. E., 1985. *Glomus aggregatum* emended: a distinct taxon in the *Glomus fasciculatum* complex. Mycologia 77:619-630.

Phillips, J. M., and D. S. Hayman, 1970. Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. Trans. Brit. Mycol. Soc. 55: 158-161.

Rose, S. L., and J. M. Trappe, 1980. Three new endomycorrhizal *Glomus* spp. associated with actinorhizal shrubs. Mycotaxon 10: 413-420.

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Wu, C.G., Y. S. Liu, Y. L. Hwuang, Y. P. Wang, and C. C. Chao. 1995. Glomales of Taiwan: *Glomus chimonobambusae* and *Entrophospora kentinensis*, spp. nov. Mycotaxon 53: 283-294.

MYCOTAXON

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# INDEX OF FUNGI DESCRIBED FROM THE ZINGIBERACEAE

B. Bussaban[1], P. Lumyong[2], E.H.C. McKenzie[3], K.D. Hyde[4] and S. Lumyong[1]

[1]Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand 50200, scboi009@chiangmai.ac.th
[2]Department of Plant Pathology, Faculty of Agriculture, Chiang Mai University, Thailand
[3]Landcare Research, Private Bag 92170, Auckland, New Zealand
[4]Centre for Research in Fungal Diversity, Department of Ecology and Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong

**Abstract** Fungi described from members of the Zingiberaceae are listed under the host genera. Within each host genus the fungi are grouped, and listed alphabetically under Oomycetes, Ascomycetes, Basidiomycetes, and anamorphic fungi. In total, 170 fungi have been described from 17 genera of Zingiberaceous plants, comprising 1 species of Oomycetes, 30 Basidiomycetes, 56 Ascomycetes, and 83 anamorphic fungi. Seven taxa have been described from *Aframomum*, 25 from *Alpinia* (host for 1 species also cited as *Catymbrium*), 22 from *Amomum*, 1 from *Catymbrium* (also on *Alpinia*), 30 from *Costus*, 18 from *Curcuma*, 10 from *Elettaria*, 1 from *Geostachys*, 3 from *Globba*, 9 from *Hedychium*, 1 from *Hitchenia*, 1 from *Kaempferia*, 1 from *Nicolaia*, 5 from *Renealmia*, 1 from *Roscoea*, 1 from *Stahlianthus*, 28 from *Zingiber*, and 7 from unknown Zingiberaceae. The fungi have been described from 34 countries, most commonly India (38 taxa), China (15 taxa), Brazil (13 taxa), Taiwan (13 taxa), Philippines (13 taxa), and Indonesia (10 taxa). The original reference, collection, and herbarium details known to us are given for each taxon.

**Keywords:** anamorphic fungi, Ascomycetes, Basidiomycetes, Oomycetes

## Introduction

The Zingiberaceae is a monocotyledonous family of tropical plants with medicinal, agricultural, and horticultural uses. The family comprises about 53 genera, with about 1200 species (Mabberley 1987; Griffiths 1992). While some papers deal with the mycota on the Zingiberaceae (e.g. Pavgi and Upadhyay 1967; Rathaiah 1980a, 1981), there is no list of fungi described from this family. Fungi have been described from 17 genera of Zingiberaceae, with most records of fungi on *Costus* (30), *Zingiber* (28), *Alpinia* (25), *Amomum* (22), and *Curcuma* (18). Although the Zingiberaceae is a family of tropical plants, 7 species of fungi described on *Alpinia*, *Hedychium* and *Renealmia*, were from plants introduced and grown in botanical gardens in Europe (Tassi 1899; Mariani 1911; Petrak 1916; Sousa da Câmara 1949; Santos 1966; Dennis et al. 1977).

Most records of fungi described on Zingiberaceae are from India (38), China (15), Brazil (13), Taiwan (13), Philippines (13), and Indonesia (10). Most of them are anamorphic fungi and Ascomycetes, with Basidiomycetes poorly represented on Zingiberaceae. However, the first fungus to be described from a Zingiberaceous plant was a Basidiomycete, *Crepidotus alpiniae*

Berk. (Hooker 1856) on *Alpinia aromatica* from Brazil. There are most records of Basidiomycetes on *Aframomum* (6), *Costus* (5), and *Amomum* (4). The best-represented Basidiomycete genus is *Uredo*, with 7 species described from Zingiberaceae.

*Aposphaeria alpiniae* on *Alpinia* sp. (Massee 1899), *Coniothyrium alpinicola* on *Alpinia nutans*, and *Septoria renealmiae* on *Renealmia cinnamomum* (Tassi 1899) were the first anamorphic fungi described. The best-represented anamorphic genus is *Cercospora*, with 4 species described on *Alpinia*, 3 species on *Curcuma*, 2 species on *Costus* and *Zingiber*, and 1 species on *Amomum, Hedychium, Hitchenia, Nicolaia*, and *Stahlianthus*.

Most Ascomycete taxa on Zingiberaceae are described from Brazil (9), China (5), India (4), Malaysia (4), Philippines (4), and Dominican Republic (4). Currently the best-represented Ascomycete genus is *Mycosphaerella*, with 5 species described from Zingiberaceae. There are most records of Ascomycetes on *Costus* (14) and *Amomum* (10). The number of species of Oomycetes, Basidiomycetes, Ascomycetes, and mitosporic fungi described from each host genus of Zingiberaceae is listed in table 1.

**Table 1. Number of species of fungi described from the Zingiberaceae.**

| Host genus | Oomycetes | Basidiomycetes | Ascomycetes | Anamorphic fungi | Total |
|---|---|---|---|---|---|
| *Aframomum* | | 6 | 1 | | 7 |
| *Alpinia* | | 2 | 8 | 15 | 25* |
| *Amomum* | | 4 | 10 | 8 | 22 |
| *Catymbrium* | | | | 1 | 1* |
| *Costus* | | 5 | 14 | 11 | 30 |
| *Curcuma* | | 2 | 1 | 15 | 18 |
| *Elettaria* | | 2 | 3 | 5 | 10 |
| *Geostachys* | | | | 1 | 1 |
| *Globba* | | 2 | | 1 | 3 |
| *Hedychium* | | 2 | 3 | 4 | 9 |
| *Hitchenia* | | | | 1 | 1 |
| *Kaempferia* | | 1 | | | 1 |
| *Nicolaia* | | | | 1 | 1 |
| *Renealmia* | | | 4 | 1 | 5 |
| *Roscoea* | | 1 | | | 1 |
| *Stahlianthus* | | | | 1 | 1 |
| *Zingiber* | 1 | 1 | 8 | 18 | 28 |
| Unknown Zingiberaceae | | 2 | 4 | 1 | 7 |
| **Total** | 1 | 30 | 56 | 84 | 170 |

* *Pyricularia distorta* was described on both host genera

The present list was prepared from an examination of *Sylloge Fungorum* (Saccardo 1882–1931, 1972), *Petrak's Lists* (Petrak 1920–1939), and *Index of Fungi* (Anonymous 1940–2001), and relevant supplements. For each fungus, bibliographic details are given; authors' names are abbreviated according to Kirk and Ansell (1992), journal titles are abbreviated according to Lawrence et al. (1968), Bridson and Smith (1991), or occasionally following Brown and Stratton (1963–1965). Publication of a name by one author in a work by another is indicated by the word 'apud' when the work is in a serial publication and by 'in' when the work is in a book. Where information is available, the host plant is indicated and collection details for the type specimen is given. Some information such as the date of collection is standardised. Fungi are recorded under the original name of the host plant; some of these names may be outdated. Some fungal names, e.g. *Ancylospora costi*, *Dactylium alpiniae*, and *Pyricularia globbae* (Sawada 1928, 1944; Siwasin and Giatgong 1971), were published without a Latin diagnosis, as required by Art. 36 of the *International Code of Botanical Nomenclature* (Greuter 2000), and are thus invalidly published. Such names are noted by an asterisk (*). Only the host of the type specimen is listed, but in the case of *Dimeriella dendrocalami*, *Pyricularia distorta* and *P. zingiberis* (Nishikado 1917; Sawada 1959; Hashioka 1971), where more than one host was given without specification of the type collection, all hosts are listed. The full citaion for the article where each fungus was described is given in the references.

## Fungi Described from the Zingiberaceae

## Host Index

### *Aframomum*

#### Basidiomycetes

***Desmellopsis aframomicola*** J.M. Yen, *Rev. Mycol. (Paris)* 34: 21 (1969).
Gabon, Kanga, on living leaves of *Aframomum citratum*, 21 Jul. 1969, G. Gilles.
***Puccinia aframomi*** Hansf., apud Wakefield & Hansford, *Proc. Linn. Soc. London* 161: 176 (1949).
Uganda, Masakka Rd, on *Aframomum citratum*, Nov. 1937, C.G. Hansford (2250).
***Puccinia aframomi-gigantei*** J.M. Yen & Gilles, *Cah. Maboké* 8: 38 (1970).
Gabon, on leaves of *Aframomum giganteum*.
***Tubulicium vermiferum* ssp. *raphidosporum*** Boidin & Gilles, *Bull. Soc. Mycol. France* 102: 283 (1986).
Gabon, on *Aframomum* sp., 8 May 1976, LY7771.
***Uredo aframomi*** Har. & Pat., *Bull. Mus. Hist. Nat. (Paris)* 5: 365 (1911).
Congo, Mandgi, on leaves of *Aframomum* sp.
***Uredo longozyi*** Bouriquet & Bassino, *Rev. Mycol (Paris)* 31: 326 (1966).
Madagascar, on *Aframomum daniellii*.

#### Ascomycetes

***Aulographum aframomi*** Hansf., *Proc. Linn. Soc. London* 156: 112 (1944).
Uganda, Entebbe Rd, on leaves of *Aframomum* sp., C.G. Hansford (3163).

### *Alpinia*

#### Basidiomycetes

***Crepidotus alpiniae*** Berk., apud Hooker, *J. Bot. (Hooker)* 8: 133 (1856).
Brazil, Rio Negro, on dead stems of *Alpinia aromatica*, R. Spruce (114).
***Marasmiellus pacificus*** Desjardin, apud Desjardin et al., *Canad. J. Bot.* 70: 533 (1992).
USA, Hawaii, Kauai, Lawai, National Tropical Botanical Garden, on dead leaves of *Alpinia purpurata*, 25 Nov. 1990, G. Wong (BISH 889).

#### Ascomycetes

***Leptosphaeria alpiniae*** Maubl., *Bull. Soc. Mycol. France* 21: 89 (1905).
Brazil, Sao Paulo, on leaf spot of *Alpinia nutans*, Puttemans.
***Linocarpon alpiniae*** K.D. Hyde, *Bot. J. Linn. Soc.* 123: 113 (1997).

Malaysia, Taman Ulu Bendol, in rain forest by side of stream, on basal stem of *Alpinia* sp., Nov. 1992, K.D. Hyde (HKU(M) 1632).

***Meliola monopla*** Cif., *Mycopathol. Mycol. Appl.* 7: 159 (1954).

[Dominican Republic] Santo Domingo, Peninsula de Samaná, Sánchez, on leaves *Alpinia aromatica*, 30 Apr. 1930, E.L. Ekman (4192).

***Mycosphaerella alpiniae*** S.Q. Chen & P.K. Chi, in Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 159 (1994).

China, Guangdong, on leaves of *Alpinia katsumadai*, Chen (114).

***Mycosphaerella alpiniicola*** S.Q. Chen & P.K. Chi, in Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 35 (1994).

China, Guangdong, on leaves of *Alpinia oxyphylla*, Chen (109).

***Pestalosphaeria alpiniae*** P.K. Chi & S.Q. Chen, in Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 35 (1994).

China, Guangdong, on leaves of *Alpinia oxyphylla*, Chen (91).

*****Phyllachora alpiniae*** Sacc. & Berl., *Atti Ist. Veneto Sci. Lett. Arti* 6: 715 (1885).

Australia, Queensland, Tallebud, on dead leaves of *Alpinia coerulea*, 1883, B. Scortechini.

***Phyllachora alpiniae*** Cooke & Massee, apud Cooke, *Grevillea* 17: 56 (1889).

Australia, Brisbane, on fading leaves of *Alpinia coerulea*, Bailey (623).

## Anamorphic fungi

***Aposphaeria alpiniae*** Massee, *Bull. Misc. Inform.*: 182 (1899).

Solomon Islands, New Georgia, on inflorescences of *Alpinia* sp., 1894, Officers of HMS Penguin.

***Cercospora alpiniae*** Syd. & P. Syd., *Ann. Mycol.* 12: 202 (1914).

Philippines, Los Banos, Laguna, Mt Maquiling, on leaves of *Alpinia* sp., 18 Dec. 1913, C.F. Baker (2221).

***Cercospora alpiniae-katsumadae*** S.Q. Chen & P.K. Chi, *J. South China Agric. Univ.* 11: 58 (1990).

China, Guangdong, on leaves of *Alpinia katsumadai*, Chen (112).

***Cercospora alpiniae-katsumadaicola*** S.Q. Chen & P.K. Chi, *J. South China Agric. Univ.* 11: 58 (1990).

China, Guangdong, on leaves of *Alpinia katsumadai*, Chen (111).

***Cercospora alpiniicola*** S.Q. Chen & P.K. Chi, *J. South China Agric. Univ.* 11: 57 (1990).

China, Guangdong, on leaves of *Alpinia oxyphylla*, Chen (102).

***Coniothyrium alpiniicola*** Tassi, *Bull. Lab. Orto Bot. Reale Univ. Siena* 2: 152 (1899).

Italy, Senensi Botanical Gardens, on leaf sheaths of *Alpinia nutans*.

*****Dactylium alpiniae*** Sawada, *Rep. Gov. Res. Inst. Formosa* 35: 102 (1928).

Taiwan, on leaves of *Alpinia speciosa*.

*****Monosporium alpiniae*** Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8: 185 (1959).

Taiwan, Taipei, on fruit of *Alpinia speciosa*, 27 & 28 Aug. 1946, C.C. Chen.

***Phomopsis alpiniae*** Sousa da Câmara, *Agron. Lusit.* 11: 57 (1949).

Portugal, Lisboa, Hortum Botanicum Facultatis Scientiarum, on living leaves of *Alpinia nutans*, 1948, T. Vasconcelos.

***Phomopsis conspicua*** Syd. & P. Syd., *Ann. Mycol.* 18: 102 (1920).

Philippines, Mindanao, Davao, Pantucan, on living leaves of *Alpinia* sp., 24 Apr. 1918, O.A. Reinking (6918).

***Phyllosticta alpiniae*** Bat., apud Batista & Vital, *Biol. Soc. Agric. Pernambuco* 19: 5 (1952).

Brazil, on *Alpinia speciosa*.

*****Phyllosticta alpiniae-kelungensis*** Sawada, *Rep. Gov. Res. Inst. Formosa* 85: 59 (1943).

Taiwan, on *Alpinia kelungensis*.

***Pseudocercospora alpiniae*** S.Q. Chen & P.K. Chi, *J. South China Agric. Univ.* 11: 48 (1990).

China, Guangdong, on leaves of *Alpinia offcinarum*, Chen (105).

***Pseudocercospora alpiniicola*** S.Q. Chen & P.K. Chi, *J. South China Agric. Univ.* 11: 48 (1990).
China, Guangdong, on leaves of *Alpinia officinarum*, Chen (106).
***Pyricularia distorta*** Hashioka, *Trans. Mycol. Soc. Japan* 12: 133 (1971).
Thailand, Mt Khaoyai, on living leaves of *Alpinia* sp. and *Catymbrium* sp., 9 Sep. 1968, Y. Hashioka.

## *Amomum*

### Basidiomycetes

***Arrhenia minuta*** Petch, *Trans. Brit. Mycol. Soc.* 27: 137 (1944).
Sri Lanka, Hakgala, on dead leaves of *Amomum* sp., May 1912, T. Petch (4547).
***Marasmius amomi*** Petch, *Trans. Brit. Mycol. Soc.* 31: 43 (1947).
Sri Lanka, Hakgala, on dead stems of *Amomum* sp., Apr. 1915, T. Petch.
***Mycena aculeifera*** Petch, *Ann. Roy. Bot. Gard. (Peradeniya)* 10: 132 (1926).
Sri Lanka, Peradeniya, on dead rhizomes of *Amomum* sp., 17 Dec. 1914.
***Uredo amomi*** Petch, *Ann. Roy. Bot. Gard. (Peradeniya)* 5: 252 (1912).
Sri Lanka, Hakgala, on *Amomum involucratum.*

### Ascomycetes

***Amphisphaeria amomi*** Henn. & E. Nyman, apud Hennings, *Monsunia* 1: 166 (1899).
Indonesia, Java, Salak, on decaying stems of *Amomum* sp., E. Nyman.
***Bertia tessellata*** Petch, *Ann. Roy. Bot. Gard. (Peradeniya)* 7: 304 (1922).
Sri Lanka, Hakgala, on dead rhizomes of *Amomum* sp.
***Gaeumannomyces amomi*** Bussaban et al., *Nova Hedwigia* 73: 488 (2001).
Thailand, Chiang Mai, Doi Suthep-Pui National Park, on healthy leaves of *Amomum siamense*, Feb. 2000, B. Bussaban (BCC4066).
***Gnomonia scitaminearum*** Höhn., *Mitt. Bot. Lab. TH Wien* 4: 7 (1932).
Indonesia, Java, on leaves of *Amomum* sp.
***Guignardia amomi*** S.M. Lin & P.K. Chi, in Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 43 (1994).
China, Guangdong, on leaves of *Amomum krervanh*, Lin (156).
***Leiosphaerella amomi*** Bussaban et al., *Nova Hedwigia* 73: 490 (2001).
Thailand, Chiang Mai, Doi Suthep-Pui National Park, on healthy leaves of *Amomum siamense*, Aug. 1999, B. Bussaban (BCC4065).
***Meliola amomicola*** F. Stevens, *Illinois Biol. Monogr.* 2: 40 (1916).
Puerto Rico, Mayaguez, Mesa, on leaves of *Amomum caryophyllata*, 15 Jun. 1915.
***Microthyrium subulatum*** P.C. Gupta, *Mycopathol. Mycol. Appl.* 54: 129 (1974).
India, U.P., Varanasi, on living leaves of *Amomum subulatum*, 17 Oct. 1964, P.C. Gupta (PCG-38).
***Mycosphaerella amomi*** P.K. Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 44 (1994).
China, Guangdong, on leaves of *Amomum compactum*, Lin (261).
***Phaeochaetia amomicola* var. *minispora*** Bat. & Peres, apud Batista et al., *Brotéria Ci. Nat.* 31: 115 (1962).
Brazil, Pernambuco, on leaves of *Amomum magnificum*, 16 Sep. 1960.

### Anamorphic fungi

***Berkleasmium nigroapicale*** Bussaban et al., *Fung. Divers.* 8: 80 (2001).
Thailand, Chiang Mai, Doi Suthep-Pui National Park, on dead pseudostems of *Amomum siamense*, 15 Oct. 2000, B. Bussaban (PDD 74415).
***Berkleasmium sutheppuiense*** Bussaban et al., *Fung. Divers.* 8: 82 (2001).
Thailand, Chiang Mai, Doi Suthep-Pui National Park, on dead pseudostems of *Amomum siamense*, 15 Oct. 2000, B. Bussaban (PDD 74416).

***Cercospora amomi*** A.K. Kar & M. Mandal, *Trans. Brit. Mycol. Soc.* 53: 358 (1969).
India, West Bengal, Darjeeling, Tung, on *Amomum dealbatum*, 1768 m, 12 May 1967, IMI 135184.
***Gonatopyricularia amomi*** Z.D. Jiang & P.K. Chi, *J. South China Agric. Univ.* 10: 11 (1989).
China, Guangdong, Yang-Chun, on living leaves of *Amomum villosum*, Feb. 1985, Z.D. Jiang & P.K. Chi (001).
***Phoma amomi*** P.K. Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 45 (1994).
China, Guangdong, on leaves of *Amomum compactum*, Lin (77).
***Ramichloridium amomi*** P.K. Chi & S.Q. Chen, in Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 46 (1994).
China, Guangdong, on leaves of *Amomum krervanh*, Chen (115).
***Rhombostilbella crus-pavonis*** Cif., Bat. & Nascim., *Atti Ist. Bot. Lab. Crittog. Univ. Pavia* 14: 13 (1957).
Brazil, Pernambuco, on *Amomum magnificum*, 22 Mar. 1956.
***Septoria amomi*** Z.D. Jiang & P.K. Chi, in Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 29 (1994).
China, Guangdong, on leaves of *Amomum villosum*, Jiang (56).

## *Catymbrium*

### Anamorphic fungi

***Pyricularia distorta*** Hashioka, *Trans. Mycol. Soc. Japan* 12: 133 (1971).
Thailand, Mt Khaoyai, on living leaves of *Alpinia* sp. and *Catymbrium* sp., 9 Sep. 1968, Y. Hashioka.

## *Costus*

### Basidiomycetes

***Pterula subtyphuloides*** Corner, *Monogr. Clavaria & Allied Genera*: 522 (1950).
Singapore, on dead twigs of *Costus* sp., 19 Mar. 1943.
***Puccinia costina*** Cummins, *Mycologia* 48: 605 (1956).
Papua New Guinea, Morobe, Boana, on *Costus* sp., 10 May 1940, Clemens (11368) [Teleomorph of *Uredo costina*].
***Uredo costicola*** J.M. Yen & Gilles, *Bull. Soc. Mycol. France* 86: 862 (1971).
Gabon, Libreville, on living leaves of *Costus lucanusianus*, 24 Nov. 1969, G. Gilles (PG 6).
***Uredo costina*** Syd., apud Sydow & Sydow, *Ann. Mycol.* 14: 355 (1916)
Philippines, Los Banos, on leaves of *Costus speciosus*, Jan. 1916, C.F. Baker (4149) [Anamorph of *Puccinia costina*].
***Uromyces dichorisandrae*** Henn., *Hedwigia* 34: 91 (1895).
Brazil, Goya, on living leaves of *Costus pumilus*, E. Ule (1987).
The host for this fungus was originally determined as *Dichorisandra* (Commelinaceae). Later, Hennings (1895b) noted that the host was not *Dichorisandra* but rather *Costus pumilus*. He suggested, therefore, that the name *U. costi* would be more appropriate for this fungus.

### Ascomycetes

***Acanthostigmella thaxteri*** Linder, *Ann. Missouri Bot. Gard.* 16: 321 (1929).
Trinidad, on *Costus spiralis*.
***Dictyopeltis costi*** Bat., *Publçōes Inst. Micol. Recife* 56: 245 (1959).
Brazil, Pernambuco, on leaves of *Costus* sp., 19 Jan. 1956.
***Dictyothyriella guianensis*** F. Stevens & Mant., *Bot. Gaz. (Crawfordsville)* 79: 274 (1925).
British Guiana, on living leaves of *Costus* sp., 16 Jul. 1925 (1005).
***Irenina costi*** F. Stevens, *Ann. Mycol.* 25: 458 (1927).
Panama, Brazos Brook reservoir, on living leaves of *Costus* sp., 22 Sep. 1924 (728a).
***Irenina parasitica*** F. Stevens, *Ann. Mycol.* 25: 454 (1927).

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***Irenopsis chandleri*** Hansf., *Proc. Linn. Soc. London* 153: 8 (1941).
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***Kerniomyces costi*** Toro, *J. Agric. Univ. Puerto Rico* 22: 452 (1939).
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Philippines, Luzon, on leaves of *Costus* sp., Apr. 1916 (Bogor 15855).
***Meliola longistipitata* var. *minor*** Cif., *Mycopathol. Mycol. Appl.* 7: 150 (1954).
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***Meliola longistipitata* var. *wakefieldii*** Hansf., *Sydowia* 9: 19 (1955).
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***Micropeltidium costi*** Bat., *Publções Inst. Micol. Recife* 56: 260 (1959).
Brazil, Pernumbuco, on leaves of *Costus* sp., 12 Dec. 1955.
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Brazil, Pernambuco, on leaves of *Costus* sp., 15 Oct. 1955.

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Taiwan, on *Costus speciosus*.
***Bipolaris costina*** Sivan., R.S. Shukla, S.K. Singh & A. Hussain, apud Sivanesan, *Trans. Brit. Mycol. Soc.* 84: 404 (1985).
India, Lucknow, on *Costus speciosus*, 9 Mar. 1981, K.P. Singh (IMI 256417).
***Cercospora costi*** F. Stevens, *Illinois Biol. Monogr.* 11: 57 (1927).
Panama, Gaturn, on leaves of *Costus* sp., 24 Aug. 1923, F. Stevens (1343).
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Taiwan, Kagi-chô, Chûho, on living leaves of *Costus speciosus*, 15 Oct. 1913, T. Kawakami.
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Tanzania, Kigoma, Kakombe, on living leaves of *Costus afer*, 31 Dec. 1963, K.A. Pirozynski (IMI 105975a, DAOM 130850).
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India, Hyderabad, Pakhal forest, on living leaves of *Costus speciosus*, 28 Sep. 1956, M.A. Salam (Hy 60).
***Parastigmatea asiatica*** Bat. & Costa, apud Batista, Costa & Maia, *Ann. Soc. Biol. Pernambuco* 15: 482 (1957).
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***Parastigmatellina asiatica*** Bat. & Costa, apud Batista & Ciferri, *Mycopathol. Mycol. Appl.* 11: 61 (1959).
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***Phaeoisariopsis costi*** A.K. Singh, S.K. Singh & Kamal, *Curr. Sci.* 53: 876 (1984).
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***Pyricularia costina*** Sarbajna, *J. Mycopathol. Res.* 28: 162 (1990).
India, West Bengal, Murshidabad, on living leaves of *Costus speciosus*, 16 Sep. 1986, K.K. Sarbajna (IMI 31114).

## *Curcuma*

### Basidiomycetes

***Klastopsora curcumae*** Höhn., *Sitzungsber. Kaiserl. Akad. Wiss., Matt.-Naturwiss. Cl., Abt. 1* 121: 339 (1912).
Indonesia, Java, Buitenzorg Botanical Garden, on leave of *Curcuma longa*, 1907, von Höhnel.
***Puccinia curcumae*** T.S. Ramakr. & Sundaram, *Proc. Indian Acad. Sci. B* 38: 192 (1953).
India, Madras, Mundage, on living leaves of *Curcuma* sp., 27 Aug. 1952, T.S. Ramakrishnan.

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**Pyrenochaetina curcumae*** Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8:145 (1959).
Taiwan, Tainan, Wanli, on leaves of *Curcuma aromatica*, 4 Nov. 1909, K. Sawada.

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***Cercospora curcumae*** Govindu & Thirum., *Sydowia* 10: 275 (1956).
India, Bangalore, Hebbal, on leaves of *Curcuma longa*, 12 Apr. 1954, H.C. Govindu (IMI 125195).
***Cercospora curcumae-longae*** Pavgi & R. Upadhyay, *Sydowia* 21: 102 (1967).
India, U.P., Varanasi, on leaves of *Curcuma longa*, 3 Jan. 1964, R. Upadhyay (MSP 341).
*Cercospora curcumina* R.K. Srivast., N. Srivast. & A.K. Srivast., *Proc. Natl. Acad. Sci. India, Sect. B, Biol. Sci.* 64: 107 (1994).
India, Madhya Pradesh, University of Gorakhpur, on leaves of *Curcuma angustifolia* (GPU 1341).
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Taiwan, Nantou, Fenshuiliao, on leaves of *Curcuma aromatica*, 8 Oct. 1910, K. Sawada.
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India, Madras, Chingleput, on leaves of *Curcuma amada*, 9 Feb. 1956, N.V. Sundaram.
***Passalora curcumae*** Purkay. & Mallik, *Beih. Nova Hedwigia* 63: 132 (1979).
India, West Bengal, on leaves of *Curcuma reclinata*.
***Phaeodactylium curvularioides*** Matsush., *Matsushima Mycol. Mem.* 1: 56 (1980).
Taiwan, Kuantzuling, on dead leaves of *Curcuma aromatica*, 6 Jun. 1978 (9082).
***Phaeorobillarda curcumae*** Pavgi & R. Upadhyay, *Sydowia* 21: 100 (1967).
India, U.P., Varanasi, on leaves of *Curcuma longa*, 12 Nov. 1963, R. Upadhyay (MSP 340).
**Phyllosticta curcumae*** Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8: 135 (1959).
Taiwan, Taipei, on leaves of *Curcuma longa*, 2 Dec. 1914, Y. Fujikuro.
***Pyricularia curcumae*** Rathaiah, *Pl. Dis.* 64: 104 (1980).
India, Assam, Diphu, on leaf of *Curcuma longa*, 9 Aug. 1977, Y. Rathaiah (IMI 216922).
***Sphaceloma curcumae*** Thirum., *Trans. Brit. Mycol. Soc.* 31: 6 (1947).
India, Kemmangundi, Mysore, on leaves of *Curcuma* sp., 9 Oct. 1945, M.J. Thirumalachar (HCIO).
***Sporidesmina malabarica*** Subram. & Bhat, *Kavaka* 15: 69 (1987).
India, Kerala, Palghat, Silent Valley, on dead petiole of *Curcuma* sp., 11 Jul. 1980, D.J. Bhat (FFSI 4328).
***Sporidesmiopsis malabarica*** Subram. & Bhat, *Kavaka* 15: 71 (1987).
India, Kerala, Palghat, Silent Valley, on dead petiole of *Curcuma* sp., 23 Apr. 1980, D.J. Bhat (FFSI 3637).
***Thirumalacharia curcumae*** Rathaiah, *Mycologia* 72: 1211 (1980).
India, Assam, Shillong, on leaves of *Curcuma longa*, Y. Rathaiah, 9 Nov. 1978 (IMI 233681).
***Vermicularia curcumae*** Syd., *Ann. Mycol.* 11: 329 (1913).
India, Madras, Kistna, Angalur, on dying leaves of *Curcuma longa*, 24 Oct. 1912, W. McRae (24).

## *Elettaria*

### Basidiomycetes

***Schroeteriaster elettariae*** Racib., *Parasit. Algen Pilze Javas* II: 28 (1900).
Indonesia, Java, on leaves of *Elettaria* sp.
***Uredo elettariae*** Thirum., *Curr. Sci.* 12: 232 (1943).
India, Mysore, Balehonnur, on *Elettaria cardamomum.*

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***Catacauma elettaria*** T.S. Ramakr. & K. Ramakr., *Proc. Indian Acad. Sci. B* 32: 99 (1950).
India, Madras, Papanasam, on living leaves of *Elettaria cardamomum*, 15 May 1949, K. Sundaram.
***Ceriospora elettariae*** Ponnappa & C.G. Shaw, *Mycologia* 70: 861 (1978).
India, Cherambane, Coorg, Karnataka, on leaf of *Elettaria cardamomum*, K.M. Ponnappa, 1 Nov. 1975 (IMI 198915).
***Placostroma elettariae*** Berk. & Broome, apud Theissen & Sydow, *Ann. Mycol.* 13: 408 (1915).
Sri Lanka, Habgalla, on leaves of *Elettaria floribunda.*

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***Phaeodactylium venkatesanum*** Agnihothr., *Proc. Indian Acad. Sci. B* 68: 208 (1968).
India, Kerala, High Ranges, Mat. Sathurangapara estate, on living leaves of *Elettaria cardamomum*, 10 Oct. 1967, V. Agnihothrudu (IMI 129936).
***Phyllosticta elettariae*** S.R. Chowdhury, *Lloydia* 21: 153 (1958).
India, Assam, Nongpoh, on leaves *of Elettaria cardamomum*, 4 Nov. 1957, S.R. Chowdhury (HCIO 25592).
***Rhabdospora elettariae*** Penz. & Sacc., *Malpigia* 15 : 235 (1901).
Indonesia, Java, Tjibodas, on stems of *Elettaria* sp.
***Sphaceloma cardamomi*** Muthappa, *Sydowia* 19: 145 (1966).
India, Mysore, Coorg, on leaves of *Elettaria cardamomum*, 5 Jan. 1965, B.N. Muthappa (MACS 250).
***Xenosporium intermedium*** Vittal, *Trans. Brit. Mycol. Soc.* 76: 513 (1981).
India, Karnataka, Nemmar, on dead rachis of *Elettaria cardamomum*, 12 Nov. 1974, B.P.R. Vittal (MUBL 2544).

## *Geostachys*

### Anamorphic fungi

***Chalara rostrata*** Nag Raj & W.B. Kendr., *Monogr. Chalara & Allied Genera*: 132 (1975).
Malaysia, Cameron Highlands, on *Geostachys rupestris*, 6 Sep. 1953, W.J. Cherewick (IMI 54897).

## *Globba*

### Basidiomycetes

***Chrysocelis globbae*** Syd., apud Sydow & Petrak, *Ann. Mycol.* 29: 165 (1931).
Philippines, Manila, on living leaves of *Globba marantina*, 9 Oct. 1923 (2984).
***Maravaria pseudosuprastomatalis*** Y. Ono & Kakish., apud Ono et al., *Trans. Brit. Mycol. Soc.* 91: 471 (1988).
Thailand, Phetchabun, Nam Nao National Park, on leaves of *Globba* sp., 22 Dec. 1985 (TSH-R7174).

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**Pyricularia globbae*** Siwasin & Giatgong, *Newslett. Int. Rice Commiss.* 20: 16 (1971).
Thailand, on *Globba* sp.

## *Hedychium*

### Basidiomycetes

***Lecanocybe lateralis*** Desjardin & E. Horak, *Sydowia* 51: 21 (1999).
Indonesia, Java, Cibodas Botanical Garden, on senescent leaves of *Hedychium flavescens*, 11 Jan. 1998, E. Horak & D.E. Desjardin (SFSU 6752).
***Typhula thindii*** Khurana, *Mycologia* 72: 714 (1980).
India, U.P., Nainital, Tiffoń Top, on stem and leaves of *Hedychium acuminatum*, 6 Aug. 1973, I.P.S. Khurana (PAN 4881).

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***Microthyriella azorica*** Dennis & Spooner, apud Dennis et al., *Kew Bull.* 32: 131 (1977).
Azores, Vila Nova, Terceira, on dead leaves of *Hedychium gardnerianum*, 25 Mar. 1975 (K).
***Mycosphaerella hedychii*** F. Stevens & P.A. Young, apud Stevens, *Bernice P. Bishop Mus. Bull.* 19: 103 (1925).
USA, Hawaii, on leaves of *Hedychium coronarium*.
***Patinellaria hedychii*** K.S. Thind & Saini, *Proc. Indian Acad. Sci. B* 67: 143 (1968).
India, U.P., Mussoorie, Jabber Khet Khud, on decaying stems and leaf sheaths of *Hedychium acuminatum*, 27 Aug. 1960, K.S. Thind (448).

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***Cercospora hedychii*** Boedijn, *Nova Hedwigia* 3: 432 (1961).
Indonesia, Java, on leaves *of Hedychium coccineum*, Jun. 1950, K.B. Boedijn.
***Macrophoma hedychii*** Mariani, *Atti Soc. Ital. Sci. Nat.* 50: 169 (1911).
Portugal, Botanical Garden, on petioles of *Hedychium coronarium*.
***Phomopsioides natalinae*** A.C. Santos, *Bol. Soc. Brot.* 40: 42 (1966).
Azores, Ilha de S. Miguel, Mata da Granja, on rhizome of *Hedychium gardnerianum*, Jun. 1960.
***Phyllosticta hedychii*** Petr., *Ann. Mycol.* 14: 168 (1916).
[Austria] Moraviae, Weisskirchen, on dead leaves of *Hedychium* sp., Oct. 1914, J. Petrak.

## *Hitchenia*

### Anamorphic fungi

***Cercospora hitcheniae*** Chidd., *Indian Phytopathol.* 12: 112 (1959).
India, Bombay, Mahabaleshwar, on leaves of *Hitchenia caulina*, 19 Jan. 1955, P.P. Chiddarwar (14).

## *Kaempferia*

### Basidiomycetes

***Uredo kaempferiae*** Syd. & P. Syd., *Ann. Mycol.* 12: 263 (1914).
Angola, Quelimane, on leaves of *Kaempferia ethela*, 8 Sep. 1913, I.B. Pole-Evans (7387).

## *Nicolaia*

### Anamorphic fungi

***Cercospora nicolaiae*** Boedijn, *Nova Hedwigia* 3: 432 (1961).
Indonesia, Java, on leaves of *Nicolaia* sp., Feb. 1949, K.B. Boedijn.

## *Renealmia*

### Ascomycetes

***Dictyopeltis domingensis*** Petr. & Cif., *Ann. Mycol.* 30: 179 (1932).
[Dominican Republic] Santo Domingo, Peninsula de Samaná, ca. 300 m, on living leaves of *Renealmia aromatica*, 30 Apr. 1930, E.L. Ekman (3595).
***Dothidella renealmiae*** Rehm, *Hedwigia* 36: 377 (1897).
Brazil, Sierra Org., on leaves of *Renealmia* sp., E. Ule.

***Micropeltis ekmanii*** Petr. & Cif., *Ann. Mycol.* 30: 205 (1932).
[Dominican Republic] Santo Domingo, Cordillera Central, Villa Altagracia, on living leaves of *Renealmia aromatica*, 7 Jan. 1930, E.L. Ekman (3811).
***Phyllachora renealmiae*** Rehm, *Hedwigia* 36: 373 (1897).
Brazil, Catharina, on leaves of *Renealmia* sp., E. Ule.

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***Septoria renealmiae*** Tassi, *Bull. Lab. Orto Bot. Reale Univ. Siena* 2: 159 (1899).
Italy, Senensi Botanical Gardens, on dying leaves of *Renealmia cinnamomum.*

## *Roscoea*

### Basidiomycetes

***Puccinia roscoeae*** Barclay, *Descr. List Uredineae Simla II*: 237 (1889).
India, Simla, on leaves of *Roscoea alpina.*

## *Stahlianthus*

### Anamorphic fungi

***Cercospora stahlianthi*** Z.D. Jiang & P.K. Chi, in Chi, *Fung. Dis. Cultivated Medicinal Plants Guangdong*: 162 (1994).
China, Guangdong, on leaves of *Stahlianthus involucrata*, Jiang (303).

## *Zingiber*

### Oomycetes

***Pythium zingiberis*** Takahashi, *Ann. Phytopathol. Soc. Japan* 18: 115 (1954).
Japan, Oosaka, on root rot of *Zingiber officinale*, Nov.1947, M. Takahashi.

### Basidiomycetes

***Puccinia zingiberis*** T.S. Ramakri., *Proc. Indian Acad. Sci. B* 44: 117 (1956).
India, Thodupuzha, on living leaves of *Zingiber officinale*, 26 Sep. 1955, T.S. Ramakrishnan.

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***Dimeriella dendrocalami*** Sawada & Yamamoto, apud Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8: 37 (1959).
Taiwan, Taipei, on leaves of *Dendrocalamus latiflorus*, *Litchi sinensis* and *Zingiber mioga*, 14 Sep. 1929, C.C. Chen.
***Hypocrella zingiberis*** Massee, *Bull. Misc. Inform.* 1899: 174 (1899).
Malaysia, Perak, on petioles of *Zingiber* sp., Ridley (10).
***Mycosphaerella zingiberis*** Shirai & Hara, *Bot. Mag. (Tokyo)* 25: 70 (1911).
Japan, Shimotsuke, on leaves of *Zingiber miogae*.
***Nectria egans*** Corner, *Gard. Bull. Straits Settlem.* 8: 135 (1935).
Malaysia, on leaves of *Zingiber crescentia*.
***Nectriella zingiberis*** F. Stevens & Atienza, *Philipp. Agric.* 20: 176 (1931).
Philippines, Laguna, Agricultural College, on rhizomes of *Zingiber officinale*, 18 Nov. 1930, F. Stevens (1126).
***Nectriella zingiberis* var. *pallida*** F. Stevens & Atienza, *Philipp. Agric.* 20: 176 (1931).
Philippines, Laguna, Agricultural College, on rhizomes of *Zingiber officinale*, 18 Nov. 1930, F. Stevens (1128).
****Phaeosphaeria zingiberis*** Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8: 67 (1959).
Taiwan, Ilan, Mt Chentou, on leaves of *Zingiber officinale*, 18 Jul. 1907, R. Suzuki.
***Rosellinia zingiberis*** F. Stevens & Atienza, *Philipp. Agric.* 20: 174 (1931).
Philippines, Laguna, Agricultural College, on rhizomes of *Zingiber officinale*, 5 Oct. 1930, F. Stevens (878).

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***Aschersonia philippinensis*** Petch, *Ann. Mycol.* 30: 119 (1932).
Philippines, Cagayan, on leaves of *Zingiber* sp., Jan. 1924 (2827).
**Ascochyta zingiberi*** Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8: 152 (1959).
Taiwan, Taipei, on leaves of *Zingiber mioga*, 16 Aug. 1929, K. Sawada.
***Ascochyta zingibericola*** Punith., *Mycol. Pap.* 159: 156 (1988).
Ethiopia, Bako, on living leaves of *Zingiber officinale*, 17 Dec. 1980 (IMI 255877a).
***Cercoseptoria zingiberis*** Rathaiah, *Mycologia* 73: 774 (1981).
India, Assam, Haflong, on leaves of *Zingiber officinale*, 21 Jul. 1978, Y. Rathaiah (IMI 231501).
***Cercospora zingiberi*** Togashi & Katsuki, *Bot. Mag. (Tokyo)* 65: 25 (1952).
Japan, Fukuoka, Takawa, Soeda, on *Zingiber mioga*, 13 Sep. 1949, S. Katsuki.
***Cercospora zingibericola*** A.K. Kar & M. Mandal, *Trans. Brit. Mycol. Soc.* 53: 359 (1969).
India, West Bengal, Murshidabad, Khargram, on *Zingiber officinale*, 1 Feb. 1967 (IMI 135186).
***Coniothyrium zingiberis*** F. Stevens & Atienza, *Philipp. Agric.* 20: 174 (1931).
Philippines, Laguna, Agricultural College, on leaves of *Zingiber officinale*, 24 Oct. 1930. F. Stevens (856).
***Fusarium oxysporum* f.sp. *zingiberi*** E.E. Trujillo, *Phytopathology* 53: 1371 (1963).
USA, Hawaii, on leaves and rhizomes of *Zingiber officinale*.
***Geotrichum zingiberis-saccharati*** Overeem, *Bull. Jard. Bot. Buitenzorg* 5: 283 (1923).
Indonesia, Java, Buitenzorg, on *Zingiber saccharati*.
**Hendersonia zingiberi*** Sawada, *Special Publ. Coll. Agric. Natl. Taiwan Univ.* 8: 156 (1959).
Taiwan, Ilan, Mt Chentou, on leaves of *Zingiber officinale*, 18 Jul. 1907, R. Suzuki.
***Memnoniella zingiberis*** V.G. Rao, *Sydowia* 16: 43 (1962).
India, Poona, on old rhizomes of *Zingiber officinale*, Jan. 1961, V.G. Rao (MACS 95).
***Phomopsis zingberis*** M.S. Ali & Saikia, *Indian Phytopathol.* 46: 228 (1993).
India, Assam, on leaves of *Zingiber officinale* (HCIO 40716).
***Phyllosticta zingiberis*** F. Stevens & Ryan, apud Stevens, *Bernice P. Bishop Mus. Bull.* 19: 133 (1925).
USA, Hawaii, on living leaves of *Zingiber zerumbet*.
***Phyllosticta zingiberis*** T.S. Ramakr., *Proc. Indian Acad. Sci. B* 15: 170 (1942).
India, Godavari and Malabar, on living leaves of *Zingiber officinale*.
**Pyricularia zingiberis*** Nishik., *Ber. Ohara Inst. Landwirt. Forsch.* 1: 216 (1917).
Japan, Kuraschiki, on living leaves of *Zingiber mioga* and *Zingiber officinale*.
***Pyriculariopsis miogae*** Matsush., *Icon. Microfungorum Matsushima Lectorum*: 121 (1975).
Japan, Chiba, Kiyozumi Exp. Forest, Univ. Tokyo, on a dead leaf of *Zingiber mioga*, Oct. 1967 (2175).
***Septoria zingiberis*** Sundaram, *Indian Phytopathol.* 14: 208 (1961).
India, Wynaad, Kerala, on living leaves of *Zingiber officinale*, 25 Sep. 1955, N.V. Sundaram (G.M. Herb. 2862).
**Vermicularia zingiberae*** Sundaram, *Yearb. Dept. Agric. Madras* 1926: 10 (1927).
India, on living leaves of *Zingiber officinale*.

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***Helicogloea indica*** Boedijn, *Bull. Jard. Bot. Buitenzorg* 14: 188 (1937).
Indonesia, Java, Tjibodas, on dead stems of Zingiberaceae, Apr. 1930, K.B. Boedijn (604).
***Mycena digitata*** Maas Geest. & E. Horak, *Biblioth. Mycol.* 159: 193 (1995).
Papua New Guinea, Morobe, Bulolo, Manki Ridge, Rd 5, on rotten rhizomes of wild ginger, 8 Nov. 1971, E. Horak (ZT 71/256).

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***Leptophyma grandispora*** M.L. Farr, *Mycologia* 79: 113 (1987).

Brazil, Terr. Roraima, Boa Vista- Sta. Elena Venezuela Rd, on living leaves of Zingiberaceae, 2 Dec. 1977, Dumont et al. (BR-873, NY).

***Linocarpon zingiberacicola*** K.D. Hyde, *Bot. J. Linn. Soc.* 123: 129 (1997).

Malaysia, Taman Ulu Bendul, in rain forest by side of stream, on basal stem of unidentified Zingiberaceae, Nov. 1992, K.D. Hyde (ML 10, HKU(M) 1920).

***Nectria sesquiphialis*** Samuels, *Mem. New York Bot. Gard.* 49: 276 (1989).

Venezuela, Edo. Bolivar, Km 110-111 S of El Dorado on road between El Dorado and Sta Elena, on leaf of Zingiberaceae, 6 Aug. 1972, Dumont (VE 7184) (Teleomorph of *Sesquicillium asymmetricum*).

***Protocreopsis zingibericola*** Yoshim. Doi, *Kew Bull.* 31: 552 (1977).

Papua New Guinea, New Britain, Rabaul, on decayed stems and leaves of Zingiberaceae, 1 Jan. 1970, Doi (TNS, F-192961).

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***Sesquicillium asymmetricum*** Samuels, *Mem. New York Bot. Gard.* 49: 276 (1989).

Venezuela, Edo. Bolivar, Km 110-111 S of El Dorado on road between El Dorado and Sta Elena, on leaf of Zingiberaceae, 6 Aug. 1972, Dumont (VE 7184) (Anamorph of *Nectria sesquiphialis*).

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# THE QUESTION OF THE SEPARATION OF DIPLOCHYTRIDIUM FROM CHYTRIDIUM sensu lato

WILL H. BLACKWELL, PETER M. LETCHER, AND
MARTHA J. POWELL
Department of Biological Sciences, The University of Alabama,
Tuscaloosa, AL 35487

## ABSTRACT

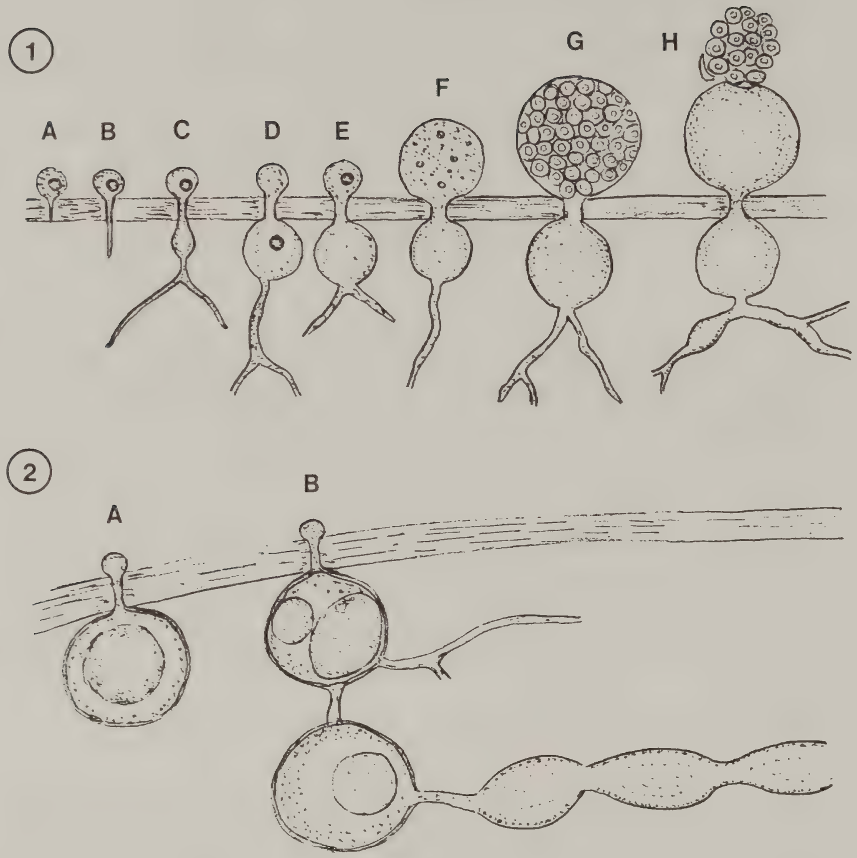
*Chytridium* has long been an accepted and inclusive genus of Chytridiomycota, underpinning the nomenclature of the Chytridiaceae and Chytridiales. However, *Chytridium* is a morphologically variable and unwieldy taxonomic assemblage. Karling divided the genus into a nonapophysate group, *Chytridium sensu stricto*, and an apophysate group, his new genus *Diplochytridium*. We analyze and compare the major morphological variations in *Chytridium sensu stricto* and *Diplochytridium*. The criteria by which Karling recognized *Diplochytridium* (the presence of an apophysis and a sometimes alternating, endo-exogenous mode of thallus development) do not both occur in all species included within *Diplochytridium*. Furthermore, some members of *Chytridium sensu stricto* exhibit, to a degree, one or the other of these traits. Endo-exogenous development is poorly known except in a few taxa. We conclude that segregation of genera from *Chytridium sensu lato* based on presence or absence of apophysis alone is of questionable validity. In addition to the morphological inconsistencies, *Diplochytridium* is nomenclaturally suspect because there is no citation of a type and because *Diplochytridium* could be interpreted as a synonym of *Chytridium*.

KEYWORDS: Chytridiomycota, development, morphology, nomenclature

## GENERIC CONCEPTS

The genus *Chytridium* Braun (1851) includes monocentric, eucarpic chytrids that form operculate, epibotic sporangia and endobiotic resting spores (cf. Sparrow, 1960). Endobiotic resting spores distinguish *Chytridium* from the operculate genus *Chytriomyces*, which is characterized by epibiotic resting spores (Karling 1945). Additionally, the developing rhizoidal system in *Chytridium* may or may not include an apophysis (=subsporangial swelling, Karling 1936). Our focus is on morphological characters that potentially separate groups of species within the operculate genus *Chytridium*, primarily the presence or absence of an apophysis and mode of thallus development.

Sparrow (1960) used the presence or absence of an apophysis as a major point of distinction in his key to *Chytridium* species. Karling (1971) noted that Whiffen (1944) and Sparrow (1960) observed that there are possibly two groups of species in *Chytridium*, those that possess an apophysis and those that do not. Karling (1971) further noted that no formal taxonomic recognition of these two species groups, as subgenera or segregate genera, had been established. Karling (1971) formally divided *Chytridium* into two groups, retaining the name *Chytridium* for nonapophysate species and erecting the genus *Diplochytridium* for apophysate taxa. Among species included in *Chytridium* (as restricted by Karling) were *C. olla* Braun (type of *Chytridium*), *C. versatile* Scherffel, *C. nodulosum* Sparrow, *C. surirellae* Friedmann, *C. sphaerocarpum* Dangeard, *C. curvatum* Sparrow, *C. rhizophydii* Karling, and *C. proliferum* Karling. Species which Karling transferred to *Diplochytridium* included *C. oedogonii* Couch, *C. scherffelii* Sparrow, *C. schenkii* Scherffel, *C. inflatum* Sparrow, *C. citriforme* Sparrow, *C. brevipes* Braun, and *C. lagenaria* Schenk. Sparrow (1973), enumerating chytrid genera, did not recognize *Diplochytridium*. Longcore (1996) listed putative species in *Diplochytridium*.



Figs. 1-2. *Chytridium (Diplochytridium) lagenaria* developmental stages (endo-exogenous development of thallus). 1A. Germling; 1B. Germ tube elongation; 1C. Beginning of germ tube expansion and rhizoidal development; 1D. Nuclear entry into germ tube and further expansion into prosporangium (= apophysis); 1E. Movement of nucleus back into zoospore cyst; 1F. Expansion of sporangium from zoospore cyst; 1G. Cleavage of zoospores within sporangium; 1H. Discharge of zoospores into vesicle at the operculate orifice of the sporangium. (Based on Karling 1936). 2A. Endogenous resting spore development within *Cladophora* sp. host. 2B. Note polycentric type of development of resting spores.

As indicated, the primary basis of separation of *Diplochytridium* and *Chytridium sensu stricto* is the presence or absence of an apophysis. However, the value of an apophysis in chytrid systematics is debatable. Koch (1957) and Miller (1968) noted difficulty in use of an apophysis as a diagnostic character in various Chytridiomycota. Umphlett and Koch (1969) found the apophysis to be a reasonably consistent structure in *Phlyctochytrium*, but Barr (1980) considered *Phlyctochytrium* divisible into several genera based on zoosporic ultrastructural features, suggesting an artificial grouping based on possession of an apophysis.

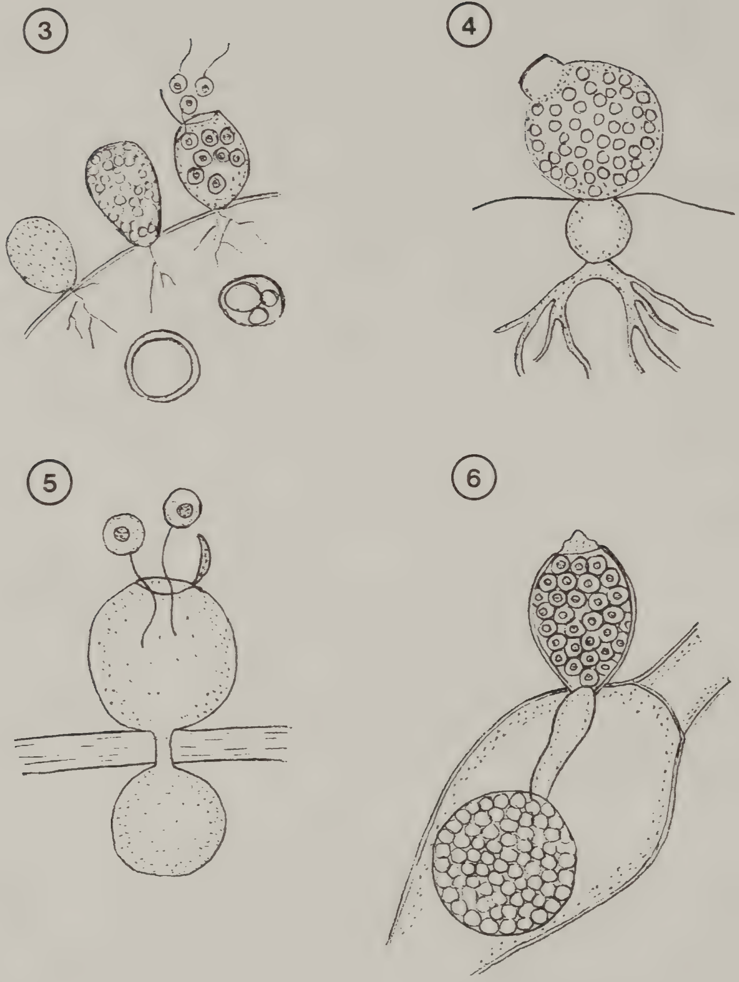
There is nothing unusual about an apophysis formed internally in the substrate, a common feature of apophysate chytrids. However, under the concept of *Diplochytridium*, more is implied than simply the presence of an apophysis. In some species of this candidate genus (e.g., *Chytridium lagenaria*) thallus development is "endo-exogenous" (Karling 1936, 1971, 1977; Sparrow 1936). In endo-exogenous development (*sensu* Karling), the epibiotic-encysted zoospore germinates and produces a germ tube that penetrates the host and develops into a rhizoidal system, including an endobiotic apophysis, e.g., *Chytridium lagenaria* (Figs. 1 A-D). The nucleus of the encysted zoospore enters the developing apophysis, temporarily leaving an enucleate zoospore case (Fig. 1D). Subsequent to nuclear migration, the apophysis of *C. lagenaria* proceeds to function as a prosporangium (Figs. 1 D-F). Accumulated protoplasm, including the nucleus, travels back into the zoospore case, generating an epibiotic zoosporangium (Figs.1 E-H). Alternatively, the apophysis can develop *in situ* as an endobiotic resting spore (Fig. 2 A). Resting spores may also form from additional apophysis-like areas deeper in the rhizoidal system (personal observation, *C. lagenaria*, Fig. 2 B). Although *C. lagenaria* is monocentric with epibiotic sporangia, the extensive endobiotic structure, including large rhizoids and occasional multiple, spaced resting spores, imparts some of the aspect of a polycentric chytrid such as *Nowakowskiella*.

The best-known example of this rather complex alternating, endo-exogenous development (*sensu* Karling) is found in *Chytridium lagenaria* (Figs. 1, 2; Karling 1936; Sparrow 1936). The development of *Chytridium oedogonii*, described by Couch (1938), also seems to be endo-exogenous, in the sense of Karling, although Couch did not use this terminology. Karling's (1936, 1971) use of the terms "endogenous" and "exogenous" is more comprehensive than Barr's (1990) usage. Barr employed these terms simply to refer, respectively, to whether the nucleus remains within, or migrates from, the zoospore cyst during thallus development. Sparrow (1960) did not view Karling's version of "endo-exogenous" development as anything greatly different from the usual pattern of acropetal nutrient flow and protoplasmic development of rhizoidal chytrids.

## MORPHOLOGICAL CONSIDERATIONS

The fidelity of characters and character combinations that supposedly delimit *Diplochytridium* is questionable when judged against a number of species of *Chytridium*. For example, *Chytridium proliferum* Karling (1967), in the nonapophysate *Chytridium sensu stricto* group (Karling 1971), shows a degree of endo-exogenous development (*sensu* Karling 1936), supposedly more characteristic of the apophysate *Diplochytridium* grouping. *Chytridium proliferum* exhibits this endo-exogenous pattern by internal proliferation of additional secondary sporangia, even though no apophysis is apparent. Similar internal proliferation of sporangia was noted (Blackwell and Powell, 2000) in the clearly apophysate *Chytridium lagenaria*, referable to the *Diplochytridium* grouping. Alternatively, a taxon may be apophysate, but lack any visible endo-exogenous development. Karling (1971) noted that endo-exogenous development is not known in the apparently nonrhizoidal, yet apophysate species, *Chytridium inflatum* Sparrow (1933) (Fig. 5). Even though *C. inflatum* seemingly lacked endo-exogenous development, Karling (1971) transferred *C. inflatum* to *Diplochytridium*.

Karling (1971) mentioned additional instances of difficulty in species placement. *Chytridium neochlamydococci* Kobayasi and Ookubo is intermediate between *Diplochytridium* and *Chytridium sensu stricto*. In *C. neochlamodococci*, the apophysis is "minute and obscure," and taxonomic alignment uncertain. Karling alluded to Canter's (1960a) observation that the zoosporangium and apophysis of *Chytridium isthmiophilum* develop simultaneously, not in an endo-exogenous sequence. Yet, Karling (1971) placed *C. isthmiophilum* in *Diplochytridium*.



Figs. 3-6. Different forms of rhizoidal systems and of apophyses structures in species for which the endo-exogenous development of thallus has not been found. 3. *Chytridium rhizophydii* developmental stages on pollen. Rhizoidal axes with no apophysis (based on Karling 1948). 4. *Chytridium (Diplochytridium) citriforme*, apophysis bearing branched rhizoids (based on Sparrow 1952). 5. *Chytridium (Diplochytridium) inflatum* with apophysis (= haustorium) not bearing rhizoidal extensions (based on Sparrow 1933). 6. *Chytridium olla* with tap-root like rhizoidal axis showing some subsporangial swelling (based on Sparrow 1971).

Another unusual species of *Chytridium* studied by Canter (1960b), *C. coleochaetes* Nowakowski, has a "sac-like endobiotic rhizoid," which could be interpreted as an apophysis or as a haustorium. Canter felt that, though unlikely, the possibility of endo-exogenous development could not be ruled out in this species. Karling (1971) placed *C. coleochaetes*, regardless of debatable morphology of the rhizoidal system, in *Chytridium sensu stricto*. Specimens of the presumably non-apophysate *Chytridium acuminatum* Braun were occasionally observed (Sparrow 1960; and personal observations of material on *Sirogonium* zygotes) to have a small, apophysis-like expansion ("endobiotic swelling," cf. Sparrow) in the upper part of the stout, main rhizoidal tube.

Exactly how to define an apophysis remains a problem. The general use of the term "apophysis" refers simply to a physical enlargement of the upper rhizoidal system without regard to development. However, two potential problems arise in assigning species to *Diplochytridium* (vs. *Chytridium sensu stricto*). First, is an apophysis definitely and consistently present? Second, if present, is the apophysis simply a subsporangial swelling with development lacking any nuclear migratory event; or does the apophysis function as a prosporangium, generating an endo-exogenous progression of development (*sensu* Karling, 1936)? Powell and Koch (1977a, 1977b) demonstrated that significant enlargement of thallus regions occurred where the nucleus was located. Thus, some regions considered as an apophysis could result from nuclear migration into the rhizoidal axis, whereas smaller subsporangial swellings could occur without entry of the nucleus into the germ tube. Karling (1971, 1977) acknowledged that developmental stages of a number of alleged taxa of *Diplochytridium* are insufficiently known to attribute to them, with certainty, an endo-exogenous thallus sequence. Karling (1971) even questioned if *Diplochytridium* would ultimately be maintained. Structures considered to be an apophysis are not necessarily homologous, cf. *C. lagenaria*, *C. citriforme, C. inflatum* and *C. olla* (Figs. 1,2,4-6). Comparative study of the development, structure and function of the apophysis of a number of chytrid genera would be a worthwhile undertaking.

Based on rhizoidal morphology, *Chytridium sensu lato* includes at least five sets (and not just two) of intergrading species. These are: 1. Apophysate, with endo-exogenous development and with the apophysis functioning as a prosporangium (Figs. 1, 2); 2. Nonapophysate rhizoidal system (Fig. 3); 3. Apophysate with the apophysis merely constituting the upper part of the rhizoidal system, without prosporangial development (Fig. 4); 4. Apophysate without rhizoidal outgrowths (haustorial) (Fig. 5); 5. Rhizoidal system taproot with some subsporangial swelling (Fig. 6). These morphological variations often found in *Chytridium* may render group placement of a given species uncertain.

Barr (1980) and Barr and Hartmann (1976) considered the morphological variation of *Chytridium*, particularly rhizoidal morphology and thallus development, to require further investigation before undertaking major additional taxonomic revision within and associated with the genus. We concur with Barr's viewpoint. If *Chytridium sensu lato,* with multiple morphological forms, is eventually upheld as a clade, this would to an extent diminish the phylogenetic value sometimes accorded certain developmental thallus types among chytrids (Whiffen 1944; Miller 1968; Powell and Koch 1977a, Barr 1980). However, given the range of variation known in *Chytridium*, it is possible that some taxa included within this genus are relatively unrelated; *Chytridium lagenaria*, for example, may eventually prove to be distinct from some of the other *Chytridium* species. Barr (2001) observed that distinctive zoospores types are found, not just when comparing orders of Chytridiomycota, but even within the order Chytridiales. Two such zoospore types in the Chytridiales are represented by the zoospores of *Chytridium olla* and *C. lagenaria* (Barr 1980, 2001, Barr and Hartmann 1976).

## NOMENCLATURAL CONSIDERATIONS

Nomenclatural acceptance of *Diplochytridium* centers on the morphology of *Chytridium olla* Braun since the type of *C. olla* is the type for *Chytridium* (cf. Article 10, ICBN, 2000) and the nomenclatural cornerstone of the family Chytridiaceae and order Chytridiales. The nomenclatural significance of *C. olla* pertains regardless of whether interpretations of the Chytridiaceae and Chytridiales are based on thallus, sporangium, and resting spore (cf. Sparrow 1960) or based on zoospore ultrastructure (Barr 1980, 2001).

Karling (1971) and Barr and Hartmann (1976) noted that the main rhizoidal axis of *C. olla* is a broadly tubular or sac-like endobiotic haustorium (Fig. 6) and is conceivably an apophysis. Sparrow (1971) confirmed the presence of this somewhat elongate, yet apophysis-like structure in examination of type material of *C. olla*, preserved on oogonia or zygotes of *Oedogonium*. Sparrow did not refer to this structure as an apophysis; however, Sparrow (1960) had previously referred to specimens of *C. olla* (Kny 1871) that exhibited an irregular or somewhat rounded, apophysis-like expansion of the rhizoidal tube. Interpretation of this upper rhizoidal area in *C. olla* as an apophysis depends upon whether a purely structural or a structural/functional definition of an apophysis is applied. Based on structure, this saccate rhizoidal area in *C. olla* is conceivably an apophysis.

Karling (1971) retained the possibly apophysate *C. olla* in *Chytridium sensu stricto*. In so doing, Karling implied that a key to species inclusion in *Diplochytridium* is an alternating, endo-exogenous mode of thallus development involving a prosporangial type of apophysis. Yet, endo-exogenous development (*sensu* Karling 1936) is a difficult feature to employ in defining and recognizing the genus *Diplochytridium*; this kind of development is clearly known in but a few taxa (e.g., *C. lagenaria*, *C. oedogonii*). Even in basic taxonomic identification, attention necessarily has to be given to developmental details.

In his descriptive distinction of *Diplochytridium* and *Chytridium* (*sensu stricto*), Karling (1971) gave the greater emphasis to the mere presence of an apophysis in *Diplochytridium*, irrespective of function. The mode of alternating, endo-exogenous thallus development was implicit as a secondary criterion for membership in *Diplochytridium*. Karling (1971), however, debated the utility of endo-exogenous development as a generic feature.

If it is the physical occurrence of an apophysis that is primarily important in defining *Diplochytridium*, then several species assigned by Karling to *Chytridium sensu stricto* might be better placed under *Diplochytridium*. Nomenclaturally most notable among these is *C. olla*, which could be argued to possess an apophysis. If *Diplochytridium* is construed to include *C. olla* then the circumscription of *Diplochytridium* would encompass the type of genus *Chytridium*, and *Diplochytridium* would thus become a later synonym of *Chytridium* (Article 14.4, ICBN 2000; McVaugh et al. 1968).

A more purely nomenclatural point suggesting rejection of *Diplochytridium* is that Karling (1971) did not designate a type for the genus (so noted by Index of Fungi, 1972)—cf. Articles 7.1, 7.2, 10.1, ICBN (2000). Karling (1971) preferenced no one species in his enumeration of taxa under *Diplochytridium*; hence, there is little basis for extrapolating a holotype specimen or illustration (cf. Articles 8.1, 9.1, 10.2, ICBN, 2000). If strictly interpreted, Article 37.1 (ICBN, 2000) dictates, because of the absence of type citation (Karling 1971), that *Diplochytridium* be considered an invalid name. We are not aware of any subsequent selection of a lectotype (Articles 9.2, 9.9, 9.10, ICBN, 2000) to serve in place of the holotype. The approximately 20 species names listed by Karling (1971) under *Diplochytridium* thus remain syntypic (Article 9.10, ICBN, 2000).

As a further nomenclatural addendum, *Index of Fungi* (1972) noted that the new species combinations listed by Karling (1971) under *Diplochytridium* were not supplied with "full reference to the author and original publication of the basionym as required by Art. 33 of the Code (1966) for valid publication." Nomenclaturally, the citation (Karling 1971) of just the epithet and the author's name of each species transferred from *Chytridium* to *Diplochytridium* constitutes only an indirect reference to each basionym (cf. Article 33.3, 32.4, ICBN, 2000). As suggested in Index of Fungi (1972), this incomplete citation renders invalid (Article 33.3, ICBN, 2000) the new species name combinations under *Diplochytridium* and compromises validation of the genus name.

Finally, the name *Diplochytridium* Karling (1971) is similar to the name *Diplochytrium* Tomaschek (1879), a probable *Olpidium* synonym (cf. Sparrow 1960). Because of the slight spelling difference in the names, *Diplochytridium* Karling is technically not a later homonym of *Diplochytrium* Tomaschek (cf. Article 53, ICBN, 2000; Karling 1971). Nonetheless, the similarity of the two names is confusing. Without explanation, *Index Nominum Genericorum* (Farr et al. 1979) contains a listing for *Diplochytrium* Tomaschek, but not *Diplochytridium* Karling.

## CONCLUSIONS

Regardless of a debatable morphological basis and nomenclatural improprieties associated with the name, *Diplochytridium* Karling has occasionally continued to be used as the name of a genus of a certain form of apophysate, *Chytridium*-like, Chytridiomycota (e.g., Lopez-Llorca and Hernandez 1996; Moore-Landecker 1996). This is understandable since *Diplochytridium* (exemplified by *C. lagenaria*) is a relatively complex form that perhaps should be highlighted within and separated from other *Chytridium*-like organisms. However, the overlapping and sometimes uncertain interspecific morphological variation in *Chytridium sensu lato* challenges the maintenance of *Diplochytridium*. Much of the difficulty in studying *Chytridium*-like organisms relates to what does and does not constitute an apophysis. Future investigations might advantageously address the homology of various apophysis-like structures (Figs. 1,2,4-6). Nomenclaturally, the potential annexation of the type of *Chytridium* (by a broad view of the circumscription of *Diplochytridium*), the lack of a designated type of *Diplochytridium*, and inadequately transferred species names mitigate against retention of the name *Diplochytridium*. The conservative course of action, consistent with the interpretation of others (Barr 1980; Barr and Hartmann 1976; Sparrow 1973), is retention of *Chytridium sensu lato* encompassing both *Diplochytridium* and *Chytridium sensu stricto*. Molecular and ultrastructural characters should help determine generic groupings that might reliably be separated from *Chytridium sensu lato*.

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# TUBER HUIDONGENSE SP. NOV. FROM CHINA

WANG YUN* HE XINGYUAN

Institute of Applied ecology, Academia Sinica, Shenyang 110015, China

ABSTRACT: A new truffle species, *Tuber huidongense*, collected from Huidong in SW China is described and illustrated. This new species is apparently mycorrhizal with *Pinus yunnanensis* or *P. armandii*. The relationship of the new species to other closely related species is discussed.
KEW WORDS: Truffle, Sichuan.

In the fall of 1989 the authors visited Huidong County, SW China, the type locality of *T. sinense* Tao & Liu (Zhang & Wang, 1990). A few specimens of *Tuber* species including *T. sinense* Tao & Liu (Tao & Liu, 1989) were collected. Three new species of *Tuber* have been discovered from the collections. Among them *T. giagansporum and T. pseudoexcavatum* were described and published in 1991 and 1998 respectively (Wang & Li, 1991; Wang *et al.* 1998). In this paper the third one, *Tuber huidongense*, is described and illustrated. *Tuber huidongense* is rare compared with *T. sinense* and *T. pseudoexcavatum* which are exported to Europe in hundreds of tones a year. But only two collections of *Tuber huidongense* have been found and collected from Huidong County. They are growing with trees of *Pinus yunnanensis* Franch. and *P. armandii* Franch. The type collection is deposited in Herbarium of Institute of Applied ecology (IFS), Academia Sinica, Shenyang, China.

**Tuber huidongense** Y. Wang **sp. nov.** (Figs 1-4)

Ascocarpa subglobosa, usque ad 5-25 mm in diam, flavida vel ochracea, glabrata. Peridium bistratum 430-500 µm crassum. Gleba solida, purpurinobruneola, venis albis. Asci sporis 2(1)-4, subglobosis vel irregularis, usque ad 60 (45) x 50 (37) µm. Ascosporae ellipsoideae, 23-25 (15) x 17-18 (20) µm, spinoreticulatae.

Habitat in ad terrata calcaream in sylvis Pini yunnanensis. Sichuan: Huidong, 26 November 1989, Y. Wang & D. C. Zhang, Wang 89923 holotypus (IFS).

Acomata more or less globose or ellipsoidal, occasionally lobed, yellowish brown with red tint, 5-25 mm in diameter, rough with scattered hairs. Peridium 430-500 µm thick, composed of two layers; the outer layer complex, 190-200 µm thick, with a crust of globose brown, thick-walled cells, below the outermost cells is a pseudoparenchymatic layer, the cells more or less globose,10-15 µm in diameter with 1-2 µm thick, brown walls; the inner layer 250-300 µm thick, composed of colourless, interwoven hyphae, 2-3 µm in diameter, gradually merge into the gleba tissue. Gleba whitish when young, becoming purplish-brown when mature; veins distinct, white, derived from many points on the periphery, branched, some of them not entirely closed; inter-ascal hyphae colourless, interwoven and thin-walled. Asci (1) 2-4 spored with an apparent stalk; young asci with no ascospores mostly globose, colourless; asci with 2 spores oval to oblong, 3 spored asci subglobose to short elliptical; 4 spored asci pyriform or ampulliform, 60 (45) x 50 (37) µm in diameter, thick-walled. Ascospores ellipsoid, in 1-spored asci (excluding ornamentation) 37-40 x 28 µm, in 2-spored asci 20-30 x 18-24 µm, in 3-spored asci 23-28 x 19 µm, and in 4-spored asci 23-26 x 17-20 µm; the wall 2-3 µm thick, brown, but pale brown in younger spores, spiny-reticulate, with bent points, irregular in mesh shape and size, (3) 4-5 (7) meshes in length, 3-5 meshes in width, the ornamentation up to 6 µm tall.

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* Permanent address: Crop & Food Research, Invermay Agricultural Center, Private Bag 50034, Mosgiel, New Zealand.

Holotype: Huangshawan, Minde, Jiangzhou, Huidong County, Sichuan, China, alt. 2070 m, under *Pinus yunnanensis* Franch., 26 November 1989, Y. Wang 89923, deposited in Herbarium of Institute of Applied ecology, Academia Sinica (IFS), Shenyang, China. Other collection examined: Huidong County, Sichuan, 26 November 1989, Y. Wang 89924.

Etymology: The specific epithet refers to the type locality of the fungus.

This species is closely related to *T. borchii* Vitt. and *T. maculatum* Vitt. ( Mello *et al.,* 2000; Trappe *et al.,* 2000; Astier, 1998; Pegler *et al.,* 1993) but differs in smaller ascospores with bend points (Fig. 2 and 4) and much smaller asci with apparent stalks (Fig. 3). This species is also noted for its two layers of peridium (Fig. 1) and spiny-reticulate ornamentation of the ascospore (Fig. 4). It is interesting that almost all the *Tuber* species collected and described from Huidong County, China, such as *T. sinense* (Tao & Liu, 1989), *T. pseudoexcavatum* (Wang *et al.* 1998).and *T. giagansporum* (Wang & Li, 1991) have spiny-reticulate ascopspores, which implies that they may be closely related phylogenetically.

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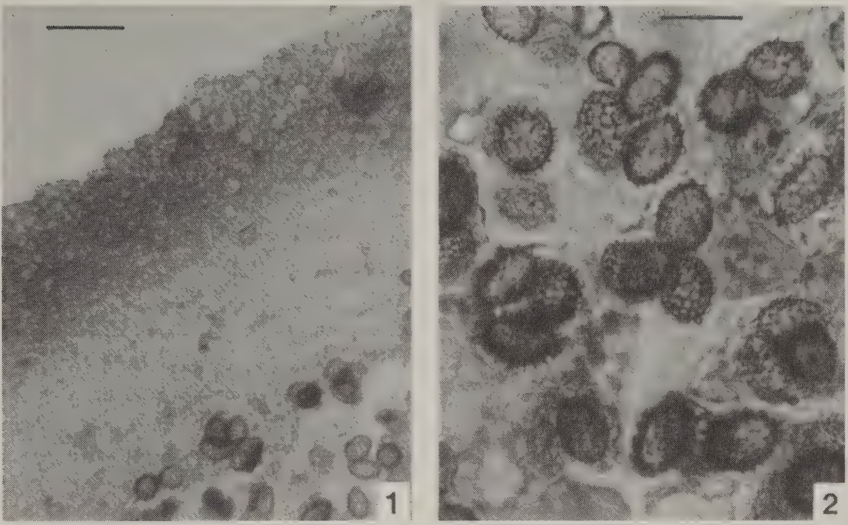
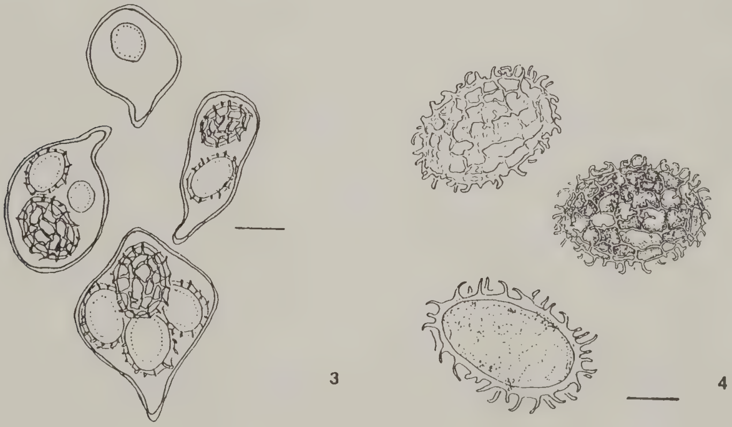


**Figs. 1-2.** *Tuber huidongense* Y. wang nov sp. (Wang 89923): **1.** Section of peridium (bar = 10 μm); **2.** Ascospores (bar = 25 μm).



**Figs. 3-4.** *Tuber huidongense* Y. wang nov sp. (Wang 89923): **3.** Different shapes of asci (bar = 20 μm); **4.** Ascospores (bar = 12 μm).

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# THE GENUS PSILOCYBE IN KERALA STATE, INDIA

K. Agretious Thomas, P. Manimohan
Department of Botany, University of Calicut, Kerala, 673 635, India

Gastón Guzmán, Fidel Tapia & Florencia Ramírez-Guillén
Instituto de Ecología, Apartado Postal 63, Xalapa, Veracruz 91000, Mexico

**Abstract:** Eight species of *Psilocybe* from Kerala State, India, are considered. *Psilocybe keralensis* sp. nov. and *P. wayanadensis* sp. nov. are described. *Psilocybe pegleriana, P. subaeruginascens*, and *P. subcubensis* are recorded for the first time from India. *Psilocybe argentina, P. coprophila*, and *P. cubensis* are new records for Kerala.

**Key Words:** Basidiomycota, Agaricales, Strophariaceae, new species, new records

## INTRODUCTION

Information on the species of *Psilocybe* (Fr.) Kumm. (Strophariaceae, Agaricales, Basidiomycota) occurring in India is rather sketchy with only a few sporadic reports available. Pegler (1977) reported *P. goniospora* (Berk. & Broome) Singer. From Kerala State, Sathe & J.T. Daniel (1980) described *P. indica* Sathe & Daniel, a poorly known species whose type seems lost (Guzmán, 1995). Manjula (1983) listed five species of *Psilocybe* viz., *P. tristis* P. Henn., *P. coprophila* (Bull.: Fr.) P. Kumm., *P. merdaria* (Fr.) Ricken, *P. caespitosa* (Berk.) Sacc., and *P. montana* (Pers.: Fr.) P. Kumm. of which *P. tristis* and *P. caespitosa* are doubtful species according to Guzmán (1983). *Psilocybe pseudoaztecorum* Natarajan & Raman (first recorded as *P. aztecorum* Heim emend. Guzmán var. *aztecorum), P. cubensis* (Earle) Singer, *P. natarajanii* Guzmán (first recorded as *P. aztecorum var. bonetii* (Guzman) Guzman), *P. crobula* (Fr.) M. Lange ex Singer, *P. muscorum* (Orton) Moser, *P. argentina* (Speg.) Singer, and *P. sabulosa* Peck (as *P. squarrosipes* Singer) were subsequently recorded from India (Natarajan & Raman, 1983; Natarajan & Raman, 1985; Guzmán, 1995). *Psilocybe kashmiriensis* Abraham was described from Kashmir Valley (Abraham, 1995); however, this species seems to belong to *Agrocybe* owing to the hymeniform pileipellis described. *Psilocybe semilanceata* (Fr.) P.Kumm. was reported from India by Stamets (1996) without any discussion; it is necessary to check this record.

While studying the agaric flora of Kerala State, India, two of us (KAT & PM) collected materials belonging to eight species of *Psilocybe* that are discussed here.

## MATERIALS & METHODS

Microscopic sections were mounted in 5% aqueous KOH. Colour codes refer to Kornerup & Wanscher (1978). All collections cited are deposited at XAL with part of each one at L.

## DESCRIPTION OF NEW SPECIES

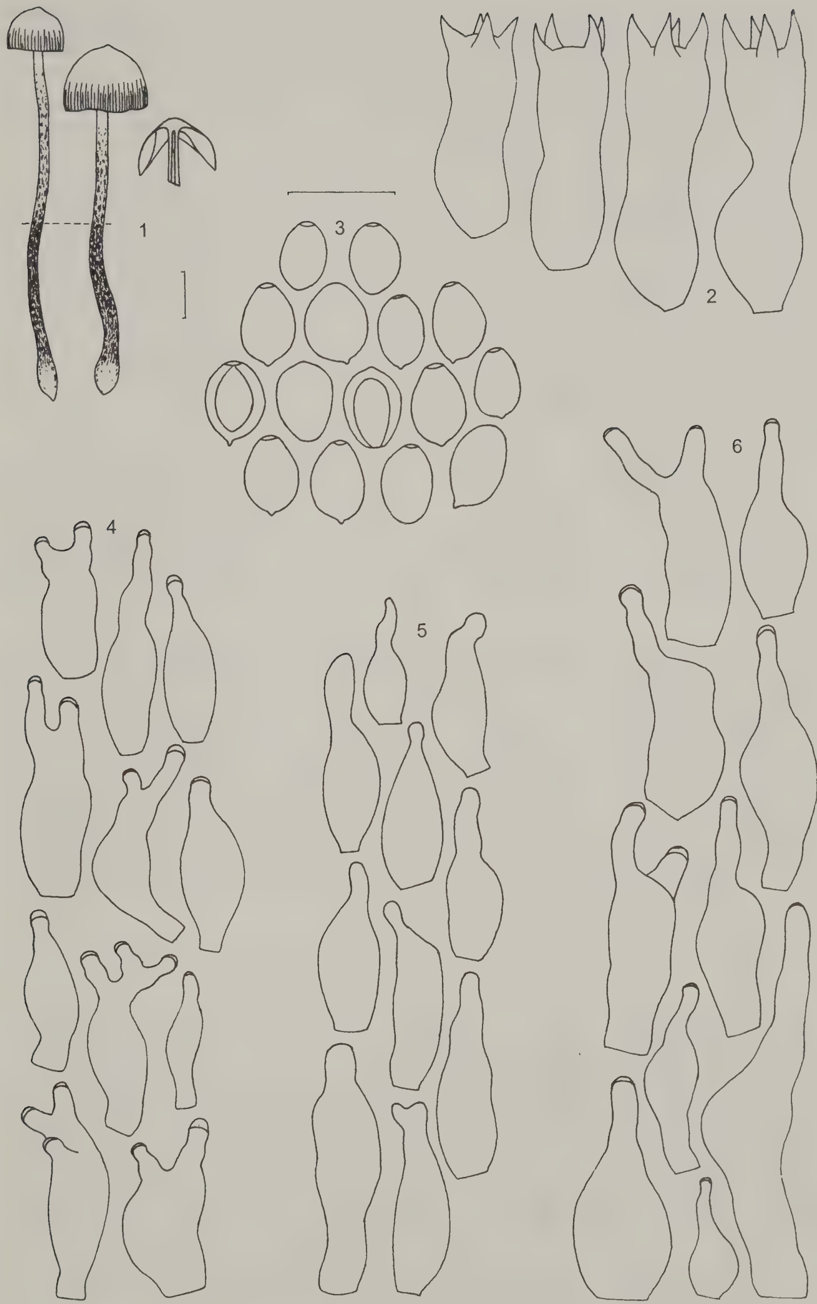
### Psilocybe keralensis K. A.Thomas, Manim. & Guzmán sp. nov. Figs. 1-6.

Pileus 6-30mm latus, conico-convexus vel convexus, umbonatus, hygrophanus, primo pallide brunneus, postea pallide aurantius, glaber, ad marginem pellucido-striatus. Lamellae adnatae, griseobrunneae, subconfertae. Stipes 30-90 x 2-5mm, radicans, ad apicem pallide luteus, ad basim griseoaurantius, caerulescens. Sporae (6.5-) 7-8 x (5-) 5.5-6 (-6.5) x (4-) 5-5.5 (-6) µm, in cumulo atrobrunneae, leniter lentiformes, subrhomboideae vel ellipsoideae, violaceobrunneae, crassitunicatae, truncato poro germinativo praeditae. Basidia (19-) 22-28 (-32) x 6.5 -7.5 (9) µm, 4- vel 2-sporigera. Pleurocystidia (11.5-) 12-20 (-27) x (3-) 4-6.5 (-7.5) µm, versiformia, hyalina. Cheilocystidia pleurocystidiis similia. Hyphae cuticulae pilei repentes, 1.5-7µm latae, hyalinae. Caulocystidia cheilocystidiis similia. Hyphae omnes fibulatae. Ad terrum. India, Kerala, Wayanad, Ponkuzhy, Thomas T-319a holotypus (XAL).

Pileus 6–30 mm diam., convex, conico-convex or subcampanulate, with a small umbo, smooth, glabrous, moist, finely translucent striate towards margin when moist, golden brown (5D7) to light brown (6D7), paler or whitish or sometimes with a tint of light orange (5A4) towards margin, hygrophanous and becoming entirely pale orange (5A3); margin decurved, entire when young, sometimes becoming wavy or eroded. Context up to 1.5 mm thick at the center, light yellow (4A4) or light orange (5A4), bluing. Lamellae adnate, greyish brown (8E3, 9E3) or brownish grey (11D2), subcrowded to close, up to 5 mm wide; edge pale, entire. Stipe 30–90 x 2–5 mm, central, terete, almost equal, fistulose; pale yellow (4A3) towards upper part, greyish orange (5B3) or brownish orange (5C3, 6C4) towards base, bluing, finely and inconspicuously floccose especially towards base, frequently radicating. Odour not distinctive. Spore-print brown (7E4) to dark brown (7F4) or greyish brown (8E3).

Spores (6.5-) 7-8 x (5-) 5.5-6 (-6.5) x (4-) 5-5.5 (-6) µm, slightly lenticular, ovo-ellipsoid to subrhomboid in face-view, ellipsoid in side-view, yellowish-brown or pale violet-brown, smooth, thick-walled, apically truncated by a germ-pore. Basidia (19-) 22-28 (-32) x 6.5-7.5 (-9) µm, subventricose or almost cylindrical with a median constriction, hyaline, 4-spored, rarely 2-spored; sterigmata up to 4.5 µm long. Pleurocystidia (11.5-) 12-20 (-27) x (3-) 4-6.5 (-7.5) µm, hyaline,

Figs. 1-6. *Psilocybe keralensis*, 1: basidiomata; 2: basidia; 3: spores; 4: cheilocystidia; 5: pleurocystidia; 6: caulocystidia; scale = 10 mm for basidiomata and 10 µm for microstructures.



ventricose-fusoid, sublageniform or utriform, rarely irregularly branching, with a short or long neck, scattered, thin-walled. Cheilocystidia (10.5-) 13-28 (-32) x (3-) 5-7 (-8) μm, hyaline, subventricose, ventricose-fusoid or sublageniform, frequently with irregular branches at the top, thin-walled, with a subgelatinous secretion at the apex. Hymenophoral trama subregular, hyaline, often with scattered conducting elements having dark turquoise blue contents; hyphae 2–21.5 μm wide, thin-walled. Context in the pileus interwoven; hyphae 2–26.5 μm wide, inflated, pale brownish, thin-walled, without encrustations. Context in the stipe composed of 2-20 μm wide, thin-walled, brownish hyphae. Pileipellis a cutis with repent, hyaline hyphae, 1.5–7 μm wide, thin-walled. Hypodermium a distinct band of brown-encrusted tramal hyphae. Stipitipellis a repent cutis, with pale brown hyphae, 1.5–7 μm wide, thin-walled. Caulocystidia 10.5–40 x 3–11.5 μm, similar to cheilocystidia in shape, hyaline, sometimes branched, occurring towards the upper part of the stipe, either in clusters or scattered, thin-walled, with a subgelatinous secretion at the apex. Clamp-connexions present on all hyphae.

On the ground, scattered, July-October. Known only from the type locality.

Specimens examined: India, Kerala State, Wayanad District, Ponkuzhy, 21 July 1999, *Thomas T-319a* (holotype, XAL; isotype, L); 25 July 1999, *Thomas T-319b* (XAL, L); 1 August 1999, *Thomas T-319c* (XAL, L); 17 October 1999, *Thomas T-319d* (XAL, L); 28 October 1999, *Thomas T-319e* (XAL, L).

This species belongs to Sect. *Cordispora* Guzmán (Guzmán, 1983), owing to the following combination of characters: bluing reaction, spores that are thick-walled, subrhombic in face view, and not longer than 9 μm, and absence of annulus. The radicating stipe brings it close to *Psilocybe harrerae* Guzmán, *P. fagicola* Heim, and *P. wassoniorum* Guzmán & Pollock that are known only from Mexico (Guzmán, 1983), but they differ in cystidial morphology and spore-size. *Psilocybe wassoniorum* has no pleurocystidia. *Psilocybe subtropicalis* Guzmán, also from Mexico as well as from Guatemala (Guzmán, 1995), is similar to *P. keralensis* in most of the microscopic features, but that species has smaller spores and a non-radicating, subbulbous, and hollow stipe-base.

## Psilocybe wayanadensis K. A. Thomas, Manim. & Guzmán sp. nov. Figs.7-12.

Pileus 10-55 mm latus, convexus vel applanatus, acute papillatus, hygrophanus, primo brunneogriseus, postea griseobrunneus, caerulescens, glaber, subviscidus, ad marginem pellucido-striatus. Lamellae adnexae vel sinuatae, griseobrunneae vel brunneae. Stipes 20-80 x 2-10 mm, cylindricus, albidus, aurantioalbidus vel griseoluteus, caerulescens, glaber, annulatus. Odor fortis, ingratus. Sporae 8-9.5 (-11) x 6.5-7 (-8) x (5-) 5.5-6 (-6.5) μm, in cumulo atrobrunneae, lentiformes, subrhomboideae vel ellipsoideae, violaceobrunneae, laeves, crassitunicatae, truncato poro germinativo praeditae. Basidia (21.5-) 26-28 (-34) x 7-9 (-10) μm,

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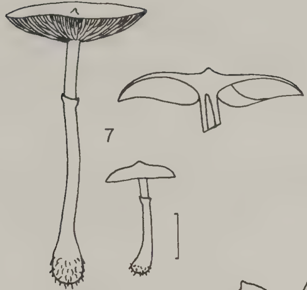
Figs. 7-12. *Psilocybe wayanadensis*, 7: basidiomata; 8: basidia; 9: spores; 10: cheilocystidia; 11: pleurocystidia; 12: caulocystidia; scale = 10 mm for basidiomata and 10 μm for microstructures



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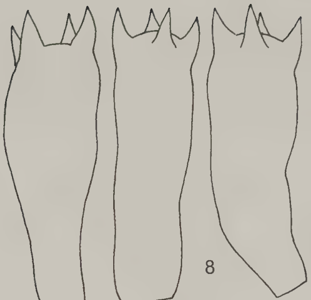

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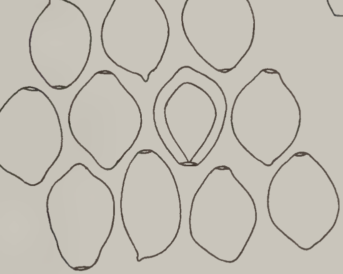

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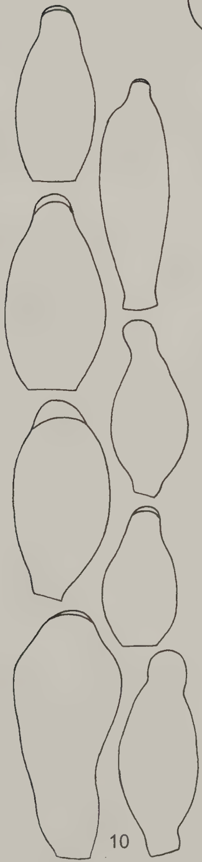

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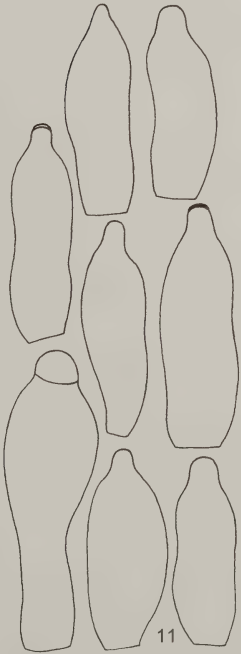

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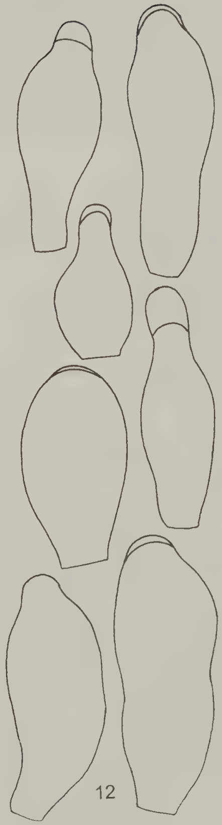

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4-sporigera. Pleurocystidia (16-) 18-30 (-34) x (7-) 9-12 (-14.5) µm, ventricoso-fusoidea, lageniformia vel utriformia, tenuitunicata, raro ad apicem crassitunicata. Cheilocystidia pleurocystidiis similia. Epicutis gelatinosus. Caulocystidia 15-30 x 6.5-12.5 µm, cheilocystidiis similia. Hyphae omnes fibulatae. Ad terrum. India, Kerala, Wayanad, Muthanga, Thomas T-320a, holotypus (XAL).

Pileus 10–55 mm diam., convex, becoming applanate to slightly depressed, with a small acute umbo at the centre, smooth, glabrous, slightly sticky when moist, translucent-striate towards margin, initially brownish grey (5C2), brownish orange (5C3) or greyish brown (5D3), uniformly turning to greyish brown (6E3, 7E3, 7D3) with brownish grey umbo (5F2, 6F2), sometimes greyish yellow (4C3), greyish orange (5B4), brownish orange (5C5), or light brown (5D6) towards centre, pale yellow (4A3) or greyish yellow (4B3) towards margin with olive brownish grey (4F2) umbo, hygrophanous; margin decurved, becoming plane, entire, sometimes becoming eroded or fissile. Context up to 4 mm thick, whitish or concolorous with the pileus surface. Lamellae adnexed to sinuate, initially greyish yellow (4B3), orange grey (5B2) or brownish orange (5C3), becoming greyish brown (6D3) to brown (6E4, 7E4), close, up to 7 mm wide; edge pale, entire. Stipe 20–80 x 2–10 mm, central, terete, hollow, orange white (4A2) or greyish yellow (4B3), smooth, with a superior, membranous, white annulus; base enlarged, with strigose basal mycelium. Stipe and pileus turning blue on bruising or aging. Odour sharp and unpleasant when mature. Spore-print dark brown (8F4, 8F5).

Spores 8-9.5 (-11) x 6.5-7 (-8) x (5-) 5.5-6 (-6.5) µm, lenticular, subrhomboidal in face-view, ellipsoid in side-view, pale brownish or pale violet-brown, smooth, thick-walled, apically truncated by a germ-pore. Basidia (21.5-) 26-28 (-34) x 7-9 (-10) µm, subventricose or cylindric to clavate, hyaline, 4-spored; sterigmata up to 4 µm long. Pleurocystidia (16-) 18-30 (-34) x (7-) 9-12 (-14.5) µm, hyaline, thin-walled, subventricose, with an acute apex and narrow base, often with a subgelatinous secretion at the apex. Cheilocystidia (11-) 13-21 (-26.5) x (5-) 6-9 (-12) µm, subventricose, ventricose-fusoid or sublageniform, thin-walled, hyaline, with an acute or obtuse apex, often with a subgelatinous secretion at the apex. Hymenophoral trama regular to subregular; hyphae 2–20 µm wide, thin-walled or wall up to 1 µm thick, hyaline to pale brownish. Context in the pileus interwoven, pale brownish, with 2–24 µm wide, hyaline hyphae, thin-walled or wall up to 1.5 µm thick. Context in the stipe composed of 2-22 µm wide, thin-walled, hyaline or faintly bluish hyphae. Pileipellis an ixocutis; hyphae 2–12.5 µm wide, thin-walled, with faint hyaline encrustations. Stipitipellis a repent cutis, with 1.5–14.5 µm wide, thin-walled, hyaline or bluish hyphae. Caulocystidia 15-30 x 6.5–12.5 µm, similar to cheilocystidia in shape, restricted to the extreme tip of the stipe, either in clusters or scattered, often with a subgelatinous secretion at the apex.

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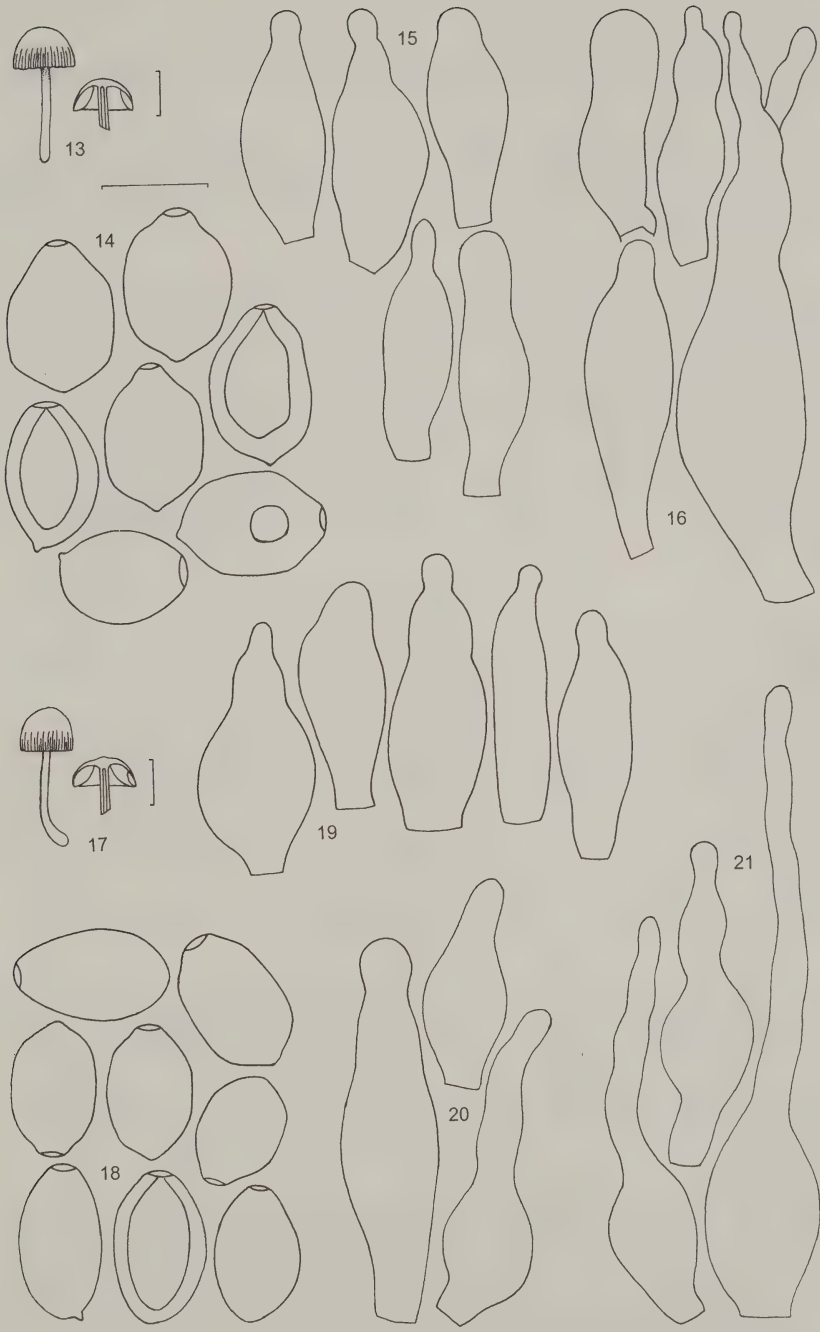
Figs.13-21. *Psilocybe argentina* and *P. coprophila*. 13-16: *Psilocybe argentina*, 13: basidiomata; 14: spores; 15: cheilocystidia; 16: pleurocystidia; 17-21: *Psilocybe coprophila*, 17: basidiomata; 18: spores; 19: cheilocystidia; 20: pleurocystidia; 21: caulocystidia; scale = 10 mm for basidiomata and 10 µm for microstructures



Clamp-connexions present.

On soil rich with wood chips, gregarious to scattered, July-October. Known only from the type locality.

Specimens examined: India, Kerala State, Wayanad District, Muthanga, 21 July 1999, *Thomas T-320a* (holotype, XAL; isotype, L); 25 July 1999, *Thomas T-320b* (XAL, L); 27 July 1999, *Thomas T-320c* (XAL, L); 31 October 1999, *Thomas T-320d* (XAL, L).

The annulus, the subrhomboid, thick-walled spores, and the bluing reaction place this new species in Sect. *Stuntzii* Guzmán (Guzmán, 1983). It is different from *P. stuntzii* Guzmán & Ott from the USA in the presence of pleurocystidia and in the shape of the cheilocystidia. *Psilocybe subaeruginascens* Hohnel from Java and southern Japan is a close species, but the spores are (8-) 9-10 (-13) x 7-8 (-8.5) x 5-7 µm and the cheilocystidia are (16-) 18-23 (-33) x (4.5-) 5.5-9 µm (Guzmán, 1983). *Psilocybe septentrionalis* (Guzmán) Guzmán (Guzmán, 1995), known only from northern Japan, is also a very close species, but differs in the size and shape of pleurocystidia (14-23 x 9-10 µm) and cheilocystidia (16-25 x 5.5-7.5 µm).

## NEW RECORDS

### Psilocybe argentina (Speg.) Singer, *Beih. Nov. Hedwigia* 29:241, 1969. Figs. 13-16

The Kerala collections agree remarkably well with the description of this species given by Guzmán (1983). *Psilocybe argentina* has already been recorded from southern India (Natarajan and Raman, 1983). The Kerala collections were found growing on cow dung and the spores measured 12-17 x 9-12 x 8.5-10.5 µm.

Specimens examined: India, Kerala State, Idukki District, Munnar, 28 August 1997, *Thomas T-150b* (XAL; L).

### Psilocybe coprophila (Bull.: Fr.) P. Kumm., *Fuhr. Pilzk.*: 71, 1871. Figs. 17-21

This species has earlier been reported from India by Watling & Gregory (1980) and Natarajan & Raman (1983). The Kerala collections were found growing on elephant dung and the spores measured 10.5-15.5 x 7.5-9.5 x 7-9 µm.

Specimens examined: India, Kerala State, Idukki District, Munnar, 28 August 1997, *Thomas T-149* (XAL; L).

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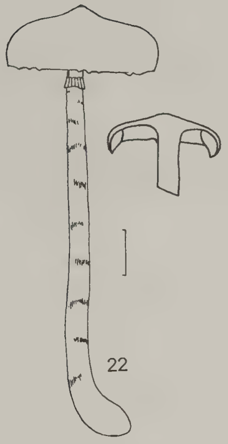
Figs.22-30. *Psilocybe cubensis* and *P. pegleriana*. 22-26: *Psilocybe cubensis*, 22: basidiomata; 23: spores; 24: cheilocystidia; 25: pleurocystidia; 26: caulocystidia; 27-30: *Psilocybe pegleriana,* 27: basidiomata; 28: spores; 29: cheilocystidia; 30: caulocystidia; scale = 10 mm for basidiomata and 10 µm for microstructures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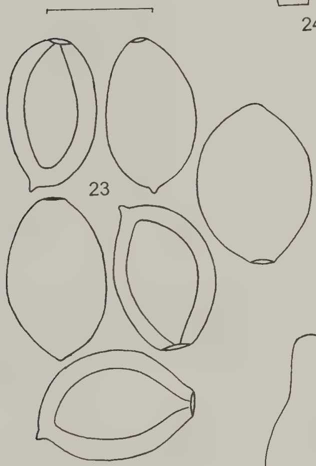
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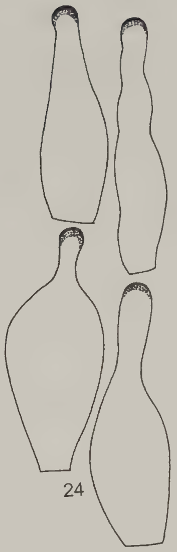
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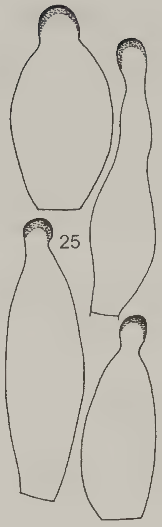
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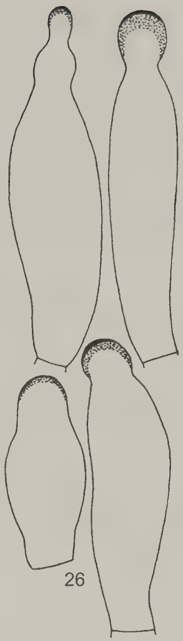
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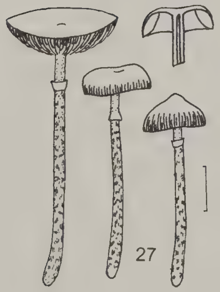
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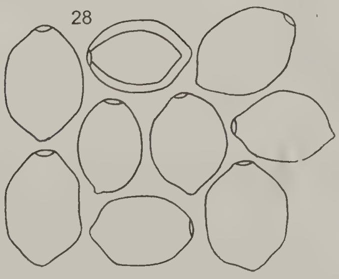
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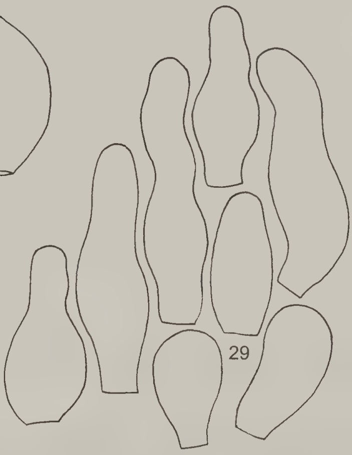
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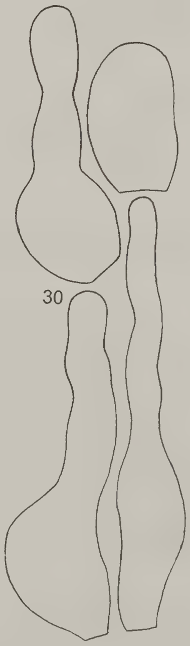
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## Psilocybe cubensis (Earle) Singer, *Sydowia* 2: 37, 1948. Figs. 22-26

The Kerala collections of this species were found growing on soil with heavy traffic of cattle. The spores measured (11-) 14-16 (-17.5) x (8-) 9-9.5 (-10.5) x (7-) 8-9 µm. The basidia are 24-32 (-36) x 9-13 (-14) µm and 4-spored. The pleurocystidia are (20-) 22-32 (-36) x (7-) 9-11 (-13) µm, hyaline, and the cheilocystidia are (16-) 19-28 (-32) x (5.5-) 7-9.5 (-12) µm. Caulocystidia were observed. All our collections were found at elevations above 2000 m. Natarajan & Raman (1983) recorded it for the first time from India.

Specimens examined. India, Kerala State, Idukki District, Munnar, 29 August 1997, *Thomas T-156* (XAL; L); 30 August 1997, *Thomas T-156c* (XAL; L); Top Station: 30 August 1997, *Thomas T-156b* (XAL; L).

## Psilocybe pegleriana Guzmán, *Doc. Mycol. 29 (116)*: 43, 2000. Figs.27-30

All the diagnostic features of *Psilocybe pegleriana* (Guzmán, 2000) such as the adnate to subdecurrent lamellae, the annulate stipe, the shape and size of spores, and the absence of pleurocystidia are shown by the Kerala collections. These collections grew on elephant dung and showed the following features: spores (8-) 8.5-10 (-12) x 6-7 (-8.5) x 5-6 (-7.5) µm; basidia 20-28 x 6.5-9.5 µm, 4-spored; and cheilocystidia (13-) 16-26 (-38) x (5-) 5.5-7 (-9) µm, hyaline. Caulocystidia were observed. This is the first Indian record of *P. pegleriana*, which hitherto was known from Mexico and Africa. *Psilocybe pseudobullacea* (Petch) Pegler from Sri Lanka (Pegler, 1986,1977) is very similar but has pleurocystidia, larger spores, and subcellular hypodermium as discussed by Guzmán (2000).

Specimens examined: India, Kerala State, Thrissur District, Guruvayoor, 11 June 1999, *Thomas T-311* (XAL; L); 17 June 1999, *Thomas T-311b* (XAL; L); 18 October 1999, *Thomas T-311e* (XAL; L); Palakkad District, Nelliyampathy, 30 August 1999, *Thomas T-311d* (XAL; L).

## Psilocybe subaeruginascens Hohnel, *Sitzungsber. Kaiserl. Akad. Wissen. Wien 123(1)*: 78, 1914. Figs. 31-35

This species as discussed in *P. wayanadensis* is known from only Java (type locality) and southern Japan. The present specimens were found on elephant dung and presented the following features: spores (8-) 9-10 (-10.5) x (5.5-) 6-7 (-7.5) x 5-6.5 µm, subrhombic and thick-walled; basidia (20-) 23-28 (-30) x (6.5-) 7-9 µm, 4-spored, hyaline; pleurocystidia 12-26 (-32) x (4-) 5-9.5 µm, hyaline, sometimes rare and irregularly branched; and cheilocystidia (14-) 15-25 (-27) x (4-) 5-6.5 (-7.5) µm, hyaline, frequently irregularly branched. All these

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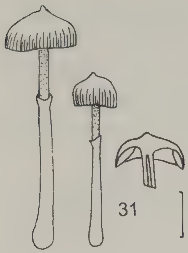
Figs. 31-40. *Psilocybe subaeruginascens* and *P. subcubensis*. 31-35: *Psilocybe subaeruginascens*, 31: basidiomata; 32: spores; 33: cheilocystidia; 34: pleurocystidia; 35: caulocystidia; 36-40: *Psilocybe subcubensis*, 36: basidiomata; 37: spores; 38: cheilocystidia; 39: pleurocystidia; 40: caulocystidia; scale = 10 mm for basidiomata and 10 µm for microstructures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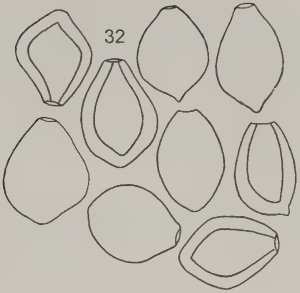
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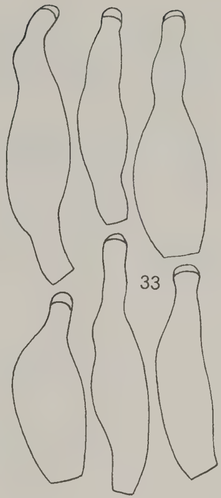
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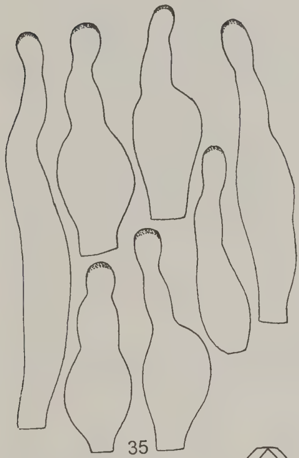
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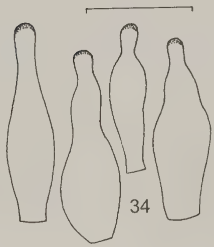
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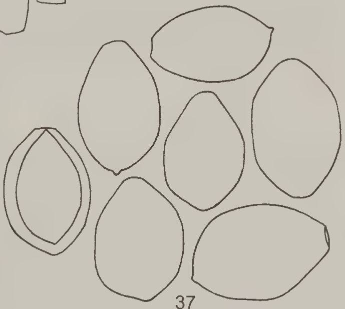
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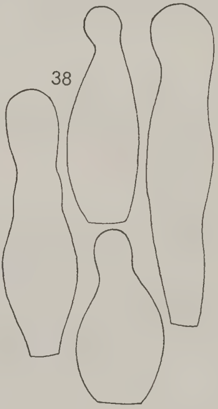
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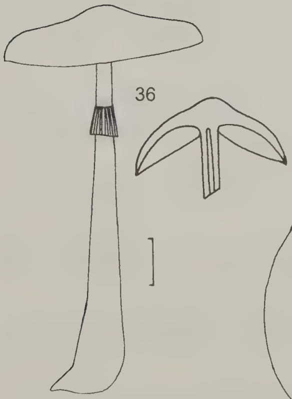
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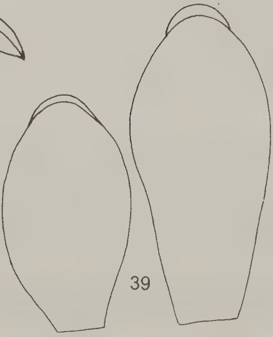
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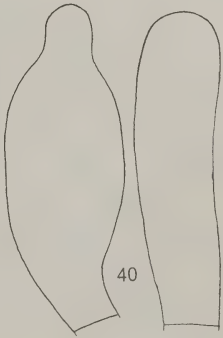
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observations agree more or less with those of Singer & Smith (1958) and Guzmán (1983), except for the caulocystidia and the branched pleuro- and cheilocystidia. Guzmán (1983) reported the following measurements: spores (7.7-) 8.8-10 (-12) (-13) x 6.6-7.7 (-8.5) x 5-6.6 µm, pleurocystidia (19-) 22-30 (-33) x (5-) 6-8 (-14) µm, and cheilocystidia (16-) 18-23 (-33) x (4.4-) 5.5-9 µm. Further studies of the type and more collections from the type locality are necessary to understand the variation of Hohnel's species.

Specimens examined: India, Kerala State, Calicut District, Vellarimala, 19 September 1999, *Thomas T-170* (XAL; L); 20 September 1997, *Thomas T-170b* (XAL; L); 8 November 1999, *Thomas T-170c* (XAL; L).

Psilocybe subcubensis Guzmán, *Mycotaxon 7:* 248, 1978. Figs. 36-40

The present collections were all from elephant dung and their spores are (9.5) 11-13 (-15) x (7.5-) 8-9 (-10.5) x (6-) 6.5-7.5 (-9) µm. This is the first Indian record of this pantropical species.

Specimens examined: India, Kerala State, Wayanad District, Muthanga, 17 June 1997, *Thomas T-76* (XAL; L); 25 June 1997, *Thomas T-76b* (XAL; L); 26 October 1997, *Thomas T-76f* (XAL; L); 25 May 1999, *Thomas T-76g* (XAL; L); 21 July 1999, *Thomas T-76h* (XAL; L).

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We thank Prof. T.J. Baroni for presubmittal review of the manuscript.

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# TWO NEW POLYPORES (BASIDIOMYCOTA) FROM TAIWAN

YU-CHENG DAI
Institute of Applied Ecology, Chinese Academy of Sciences,
Shenyang 110016, China

SHENG-HUA WU WEN-NENG CHOU
Department of Botany, National Museum of Natural Science,
Taiwan 40419

## ABSTRACT

*Perenniporia cystidiata* and *Ceriporia crassitunicata* are described as new from Taiwan. The former species is distinguished from other species of the genus by having a stipe and cystidia. The latter species is characterized by cream coloured basidiocarps, distinctly thick-walled hyphae, and by small and oblong-ellipsoid basidiospores.

Key words: *Ceriporia crassitunicata, Perenniporia cystidiata,* taxonomy

## INTRODUCTION

During a study on the collections of polypores from Taiwan, one species of *Ceriporia* Donk and one of *Perenniporia* Murrill were found, for which no existing names could be discovered. We described them here as new.

The microscopic routine used in the study is as presented by Dai (1999). In the text the following abbreviations are used: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = quotient of the mean spore length and the mean spore width in each specimen (L/W ratio). In presenting the variation in the size of spores, 5% of the measurements were excluded from each end of the range, and are given in parentheses; KOH stands for 5% potassium hydroxide, and CB is the abbreviation of Cotton Blue. CB+ means cyanophilous and CB– acyanophilous; IKI– means both inamyloid and indextrinoid in Melzer's reagent. Herbarium acronyms are as listed in Holmgren *et al.* (1990).

## TAXONOMY

**Perenniporia cystidiata** Y.C. Dai, W.N. Chou & Sheng H. Wu, *spec. nova* (Fig.1)
Carpophorum annuum, solitarium, stipitatum; pileus circularis, cinereos-brunneus; facies pororum ochracea, pori 3–4 per mm. Systema hypharum dimiticum, hyphae

generatoriae fibulatae, hyphae skeletales 4.5–6.5 µm in diam. Sporae ellipsoideae, 6.2–7.8 × 4.4–5.2 µm.

Type: Taiwan, Nantou, Lianhuachi, on ground, 5.VII.1995 *Chou 1011* (TNM F3505, holotype).

Etymology. — *cystidium* (Lat., noun), referring to cystidia which are present in hymenium.

Basidiocarps annual, with a distinct lateral stipe, solitary. Pileus circular, up to 5 cm wide, 8 mm thick; margin undulating, blunt, more or less reflexed when dry. Pileal surface greyish to greyish brown, smooth. Pore surface ochraceous when dry; pores round to angular, 3–4 per mm, tube mouths entire to slightly lacerate. Context cream to ochraceous, soft corky, up to 3 mm thick. Tubes cream to pale straw colour, corky when dry, up to 5 mm long. Stipe bearing a black cuticle, glabrous, slender, up to 3 cm long, and 5 mm in diam.

Hyphal system dimitic; generative hyphae with clamp connections; skeletal hyphae dominant, dextrinoid, strongly CB+, hyphae unchanged in KOH.

*Context.* — Generative hyphae hyaline, thin-walled, frequently with clamp connections, rarely branched, 3–4.5 µm in diam; skeletal hyphae hyaline, fairly thick-walled with a wide lumen, sometimes collapsed, more or less straight, unbranched, 4.5–6.5 µm in diam.

*Tubes.* — Generative hyphae hyaline and thin-walled, frequently with clamp connections, occasionally branched, 2.5–3.8 µm in diam. Skeletal hyphae hyaline, thick-walled with a medium lumen, more or less winding, subparallel along the tubes, 3–4.3 µm in diam. Cystidia frequent, hyaline, thick-walled, slightly dextrinoid, CB+, smooth or covered with very fine apical crystals, 25–40 × 12–18 µm. Subhymenium indistinct; basidia clavate, with four sterigmata and a basal clamp, 15–20 × 6.5–8.5 µm; basidioles in shape similar to basidia, but slightly smaller.

*Spores.* — Basidiospores ellipsoid, not truncate, hyaline, thick-walled, smooth, IKI–, strongly CB+, (5.5–)6.2–7.8(–8.4) × (4.1–)4.4–5.2(–5.5) µm, L = 7.09 µm, W = 4.92 µm, Q = 1.44 (30 spores were measured from the type material).

*Perenniporia* is a well-defined genus among polypores, and it is characterized by dimitic hyphal structure with clamps on generative hyphae, thick-walled, ellipsoid or truncate basidiospores, and by causing a white rot. Another important character for the genus is the cyanophilous reaction with Cotton Blue: spores and hyphae of all species in the genus are cyanophilous. The dextrinoid reaction with spores and hyphae are variable among the species, and some species even have amyloid hyphae, e.g. *Perenniporia narymica* (Pilát) Pouzar. The morphology of the vegetative hyphae was emphasized for *Perenniporia* (Corner, 1989), and in such case the genus has a narrow concept.

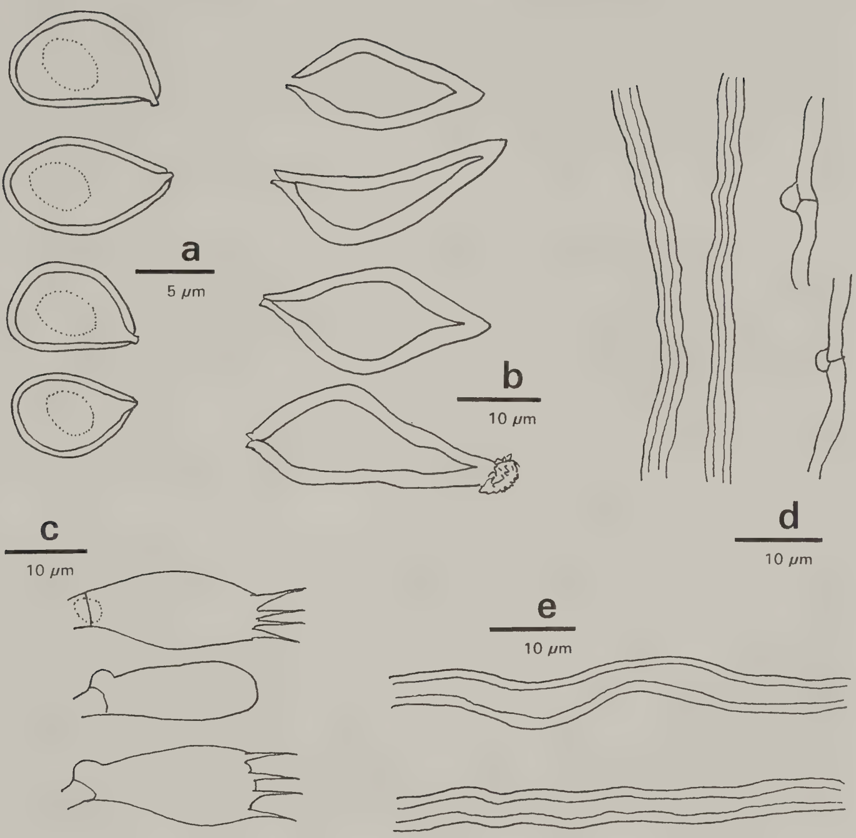
a
5 μm
b
10 μm
c
10 μm
d
10 μm
e
10 μm

Fig. 1. Microscopic structures of *Perenniporia cystidiata* Y.C. Dai, W.N. Chou & Sheng H. Wu (drawn from holotype). —a) Basidiospores. —b) Cystidia. —c) Basidia and basidioles. —d) Hyphae from trama. —e) Skeletal hyphae from context.

*Abundisporus* Ryvarden, *Loweporus* J.E. Wright, *Microporellus* Murrill, *Pyrofomes* Kotl. & Pouzar, and *Vanderbylia* D.A. Reid are the related genera to *Perenniporia*, and the definations of some genera were overlapped. Recently extensive studies on *Perenniporia* and related genera were carried out (Decock and Ryvarden, 1999; Hattori and Lee, 1999; Decock *et al.*, 2000; Decock, 2001; Decock and Laurence, 2001). In this paper we mostly followed the generic definitions of Ryvarden (1998), but special emphasis is laid on two characters: the pigmentation of spores and the cyanophilous reaction with Cotton Blue. The species with coloured spores are included in *Abundisporus*, and *Perenniporia* is for species having hyaline spores.

*Perenniporia cystidiata* is distinguished from other species of *Perenniporia* by having a stipe and cystidia, a unique combination in the genus. Among the species in *Perenniporia*, *P. cystidiata* is similar to *P. celtis* T.T. Chang & W.N. Chou, and the latter species was described from Taiwan as well (Chang and Chou, 1999). Type material of *P. celtis* was studied (TFRI 802 in TAIF). It has sessile basidiocarps, and its skeletal hyphae are wider than in *Perenniporia cystidiata* (in context: 5–8 μm in diam vs. 4.5–6.5 μm in diam; in trama: 4–6 μm in diam vs. 3–4.3 μm in diam). The critical differences are seen in the basidiospores: *Perenniporia cystidiata* has non-dextrinoid and smaller basidiospores (6.2–7.8 × 4.4–5.2 μm), while spores of *P. celtis* are dextrinoid and larger (7.6–9 × 5–6 μm).

Within *Perenniporia* only *P. celtis*, *P. decurrata* Corner, *P. inflexbilis* (Berk.) Ryvarden, and *P. martius* (Berk.) Ryvarden have cystidia. *Perenniporia decurrata* has pileate fruitbodies and smaller spores (3.5–4 × 2.5–3 μm, Corner, 1989). Its cystidia are thin-walled and smaller (15–25 × 5–8 μm, Corner, 1989). *Perenniporia inflexbilis* has very small basidiocarps (5–18 mm in longest dimension) and smaller pores (6–9 per mm). Its cystidia are thin-walled (15–25 × 5–8 μm, Corner, 1989), and its spores are dextrinoid and smaller (5–6.5 × 4–4.5 μm, Corner, 1989). *Perenniporia martius* has pileate basidiocarps and a perennial habit. Its pores are smaller (4–6 per mm), and its basidiospores are longer and dextrinoid (8–10 × 4–5 μm, Decock and Figueroa, 2000). Cystidia were reported in *Perenniporia clelandii* (Lloyd) Ryvarden (Corner, 1989), but Decock *et al.* (2000) mentioned that cystidia were absent in the species. *Vanderbylia peninsularis* Corner was described from Southeast Asia, and it has a trimitic hyphal system, thick-walled cystidia, and cyanophilous hyphae and basidiospores. It is therefore similar to *P. cystidiata*. However, *V. peninsularis* does not produce a stipe and its spores are subglobose (6–8 × 4.6–6.5 μm, Decock, 2001).

*Perenniporia stipitata* Ryvarden was described from Brazil, South America, and it is the only other stipitate species in *Perenniporia* (Ryvarden, 1987). *P. stipitata* resembles *P. cystidiata* by having a lateral stipe, but it is distinguished from the later species by its smaller pores (8–10 per mm) and smaller and dextrinoid spores (5–6 × 3–4 μm, Ryvarden, 1987). In addition, it lacks cystidia.

**Ceriporia crassitunicata** Y.C. Dai & S.H. Wu, *spec. nova* (Fig. 2)
Carpophorum annuum, resupinatum; facies pororum cremea; pori 2–3 per mm. Systema hypharum monomiticum, hyphae generatoriae septatae, hyphae subiculi 4–5 µm in diam. Sporae oblongeae vel ellipsoideae, IKI–, CB–, 3.4–4.1 × 1.6–2 µm.

Type: Taiwan, Nantou, Lianhuachi, alt. 700 m, on branch of angiosperm, 5.VI.2001 *Wu 0106* (TNM, holotype).

Etymology. — *crassus* (Lat., adj.), thick; *tunica* (Lat., noun), skin; *crassitunicata* referring to the thick-walled hyphae.

Basidiocarps annual, resupinate, cottony to tough and very light in weight when dry, up to 4 cm long, 2 cm wide, and 2 mm thick. Margin very thin; pores usually extend to the very edge. Pore surface cream to very pale yellowish cream; pores round to angular, 3–4 per mm, tube mouths lacerate to dentate. Subiculum cream, soft corky, up to 1 mm thick. Tubes cream, soft corky to tough, up to 1 mm long.

Hyphal system monomitic; generative hyphae with simple septa, thin- to distinctly thick-walled, IKI–, CB+, unchanged in KOH.

*Subiculum.* — Hyphal structure homogeneous; hyphae fairly thick-walled to distinctly thick-walled, frequently simple septate, occasionally branched, more or less at right angle, interwoven, 3–6 µm in diam.

*Tubes.* — Hyphae in trama varying from thin-walled to distinctly thick-walled. Thin-walled hyphae mostly present in subhymenium, hyaline, frequently simple septate and branched, strongly winding, 2–3 µm in diam. Thick-walled hyphae mostly present in central trama, occasionally simple septate, interwoven, 3–5.5 µm in diam. Subhymenium distinct, made up of delicate, hyaline and thin-walled hyphae; basidia clavate, with four sterigmata and a simple basal septum, 8–12 × 4–5.5 µm; basidioles in shape similar to basidia, but smaller.

*Spores.* — Basidiospores oblong-ellipsoid, hyaline, thin-walled, smooth, IKI–, CB–, (3.2–)3.4–4.1(–4.2) × (1.5–)1.6–2(–2.1) µm, L = 3.78 µm, W = 1.85 µm, Q = 2.04 (30 spores were measured from the type material).

*Ceriporia crassitunicata* is characterized by cream coloured basidiocarps, distinctly thick-walled hyphae, small and oblong-ellipsoid basidiospores. Although hyphae of the species are distinctly thick-walled, they bear simple septa, so the hyphal structure is still monomitic. The similar case occurs in other genera such as *Rigidoporus* Murrill [*R. crocatus* (Pat.) Ryvarden, *R. ulmarius* (Sowerby) Imazeki etc.] and *Schizopora* Velen. [*S. flavipora* (Cooke) Ryvarden and *S. paradoxa* (Fr.) Donk etc.].

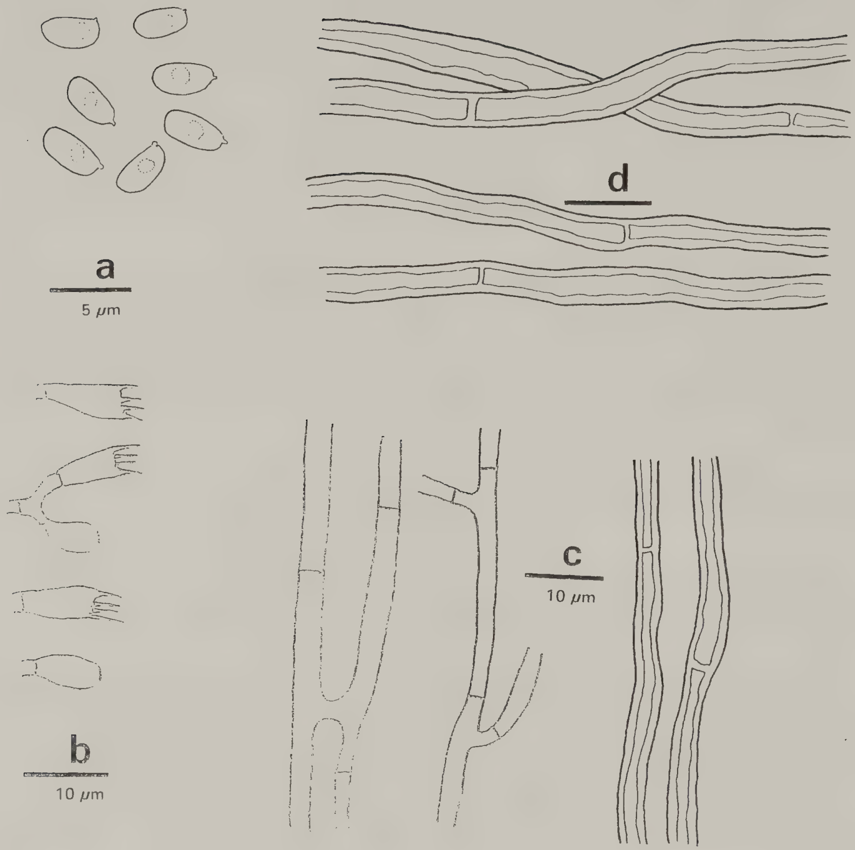

Fig. 2. Microscopic structures of *Ceriporia crassitunicata* Y.C. Dai & S.H. Wu (drawn from holotype). —a) Basidiospores. —b) Basidia and basidioles. — c) Hyphae from trama — d) Hyphae from context

*Ceriporia crassitunicata* is somehow similar to *C. viridans* (Berk. & Broome) Donk, but the basidiospores of latter species are allantoid and they are longer (4–5 × 1.5–2 µm) than in the new species. In addition, basidiocarps of *C. crassitunicata* are tough, and its tramal hyphae are distinctly thick-walled; while basidiocarps of *C. viridans* are soft corky, and its tramal hyphae are thin-walled.

In the genus *Ceriporia,* a number of species have narrow spores (the width less than 2 µm). *Ceriporia aurantiocarnescens* (Henning) M. Pieri & B. Rivoire is similar to *C. crassitunicata* in the dimensions of pores and basidiospores (3–4 per mm, 3.3–4 × 1.8–2 µm, Pieri and Rivoire, 1997), but its spores are curved, and its pores are orange. In addition, its tramal hyphae are parallel, and its subicular hyphae are strongly encrusted (Pieri and Rivoire, 1997). *Ceriporia herinkii* Vampola differs from *C. crassitunicata* by its reddish pores, and in particular by its cylindric and longer spores (4.5–5.5 × 1.3–1.8 µm, Vampola and Pouzar, 1996). *Ceriporia mellita* (Bourdot) Bondartsev & Singer has longer and cylindrical spores (5–5.5 × 1.5–2 µm), and its pore surface is salmon coloured (Pieri and Rivoire, 1997). *Ceriporia microspora* I. Lindblad & Ryvarden has similar spores (3.8–4.5 × 1.6–2 µm, Lindblad and Ryvarden, 1999) as in *C. crassitunicata.* However, its basidiocarps become brittle when dry (vs. tough in the new species), and it has distinctly smaller pores (6–8 per mm, Lindblad and Ryvarden, 1999). Furthermore, hyphae in *C. microspora* are thin- to slightly thick-walled. *Ceriporia spissa* (Schwein.) Rajchenb. differs from C. *crassitunicata* by its smaller pores (7–9 per mm), longer spores (4–6 × 1.5–2 µm), and thin-walled subicular hyphae (Pieri and Rivoire, 1997). *Ceriporia vermicularis* M. Pieri & B. Rivoire differs from *C. crassitunicata* by its larger pores (1–2 per mm) and longer, but narrower spores (6–7 × 0.8–1 µm, Pieri and Rivoire, 1997). *Ceriporia alachuana* (Murrill) Hallenb. is somehow similar to *C. crassitunicata* by oblong-ellipsoid spores, however, the former one has smaller pores (4–6 per mm vs. 3–4 per mm in the new species), and its spores are larger than in the new species (4–5 × 2–2.5 µm vs. 3.4–4.1 × 1.6–2 µm).

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# FOMITIPORIA TIBETICA, A NEW SPECIES OF HYMENOCHAETACEAE

YU-CHENG DAI
Institute of Applied Ecology, Chinese Academy of Sciences,
Shenyang 110016, China

MU ZANG
Kunming Institute of Botany, Chinese Academy of Sciences,
Kunming 650204, China

## ABSTRACT

*Fomitiporia tibetica* is described as a new species; it is characterized by annual growth habit, monomitic hyphal structure, triquetrous hymenial setae, dextrinoid and cyanophilous basidiospores, and by growth on gymnosperms. *F. tibetica* is closely related to *F. dryadea* (= *Inonotus dryadeus*), but the later species has perennial growth habit, ventricose setae, and it usually grows on *Quercus*.

Key words: Basidiomycota, polypore, taxonomy

## INTRODUCTION

During a survey of species in the polypore genus *Fomitiporia* Murrill (the *Phellinus robustus* complex) some Chinese specimens collected on both gymnosperms and angiosperms were treated as *F. dryadea* (Pers.:Fr.) Y.C. Dai, but some differences were mentioned (Dai, 1999). After studying more collections from Southwest China, it turned out that material collected on gymnosperms is different from *F. dryadea,* which usually grows on *Quercus* in Europe, and the new species is described here as *Fomitiporia tibetica* Y.C. Dai & M. Zang.

*Fomitiporia dryadea* (= *Inonotus dryadeus*) was reported on both angiosperms (mostly *Quercus*) and gymnosperms (mostly *Abies*) in North America (Gilbertson and Ryvarden, 1986), and the differences of the species on *Quercus* and *Abies* were not well known.

*Fomitiporia* was set up nearly a century ago (Murrill, 1907), and it is generally known as the *Phellinus robustus* complex. The genus was treated as a synonym of *Phellinus* Quél. by most mycologists, but the species in the genus have hyaline, thick-walled, dextrinoid and cyanophilous basidiospores, and these characters make the genus distinguishable from the *Phellinus sensu lato*. Recently DNA studies have demonstrated that *Fomitiporia* is a distinct group in the family of Hymenochaetaceae (Fischer, 1996; Wagner and Fischer, 2001).

The microscopic routine used in the study is as presented by Dai (1999). In the text the following abbreviations are used: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = quotient of the mean spore length and the mean spore width in each specimen (L/W ratio). In presenting the variation in the size of spores, hyphae, setae and basidia, 5% of the measurements were excluded from each end of the range, and are given in parentheses; KOH stands for 5% potassium hydroxide, and CB is the abbreviation of Cotton Blue. CB+ means cyanophilous and CB– acyanophilous; IKI– means both inamyloid and indextrinoid in Melzer's reagent. Herbarium acronyms are as listed in Holmgren *et al.* (1990).

## DESCRIPTION

**Fomitiporia tibetica** Y.C. Dai & M. Zang, *spec. nova* (Fig. 1)
Carpophorum annuum, pileatum; facies pororum cineres-brunnea, pori 4–6 per mm. Systema hypharum monomiticum, hyphae septatae, setae raro vel adsunt in hymenio. Sporae globosae, crassitunicatae, dextrinoideae, CB+, 6.8–8 × 6–7.5 µm.

Type: China. Xizang Autonomous Region (Tibet), Bomi County, Zamu Forest Farm, alt. 3300 m, on living tree of *Abies*, 13.IX.1976 *Zang 895* (HKAS 5895, holotype).

Basidiocarps annual, pileate, solitary, corky and light in weight when dry, pileus dimidiate or applanate, projecting up to 10 cm, 15 cm wide and 3 cm thick at base. Pileal surface deep brown, azonate, velutinate, irregularly cracked when old; margin greyish brown, obtuse. Pore surface greyish brown, becoming cracked with age; pores round to angular, 4–6 per mm, tube mouths mostly entire, sometimes more or less lacerate. Context umber brown, fibrous to corky, concentrically zonate, up to 1 cm thick. Tubes greyish brown, fragile to brittle when dry, up to 2 cm long, readily detachable from context in dry specimens.

Hyphal system monomitic; all septa without clamp connections; tissues darkening but otherwise unchanged in KOH.

*Context.* — Generative hyphae varying from hyaline and thin-walled to yellowish and fairly thick-walled, frequently simple septate and branched, straight, regularly arranged, IKI–, CB–, (5–)5.3–8(–9) µm in diam. Some hyphae distinctly thick-walled, dark brown, straight, but occasionally simple septate, (6.5–)7.5–10(–11) µm in diam.

*Tubes.* — Tramal hyphae varying from hyaline and thin-walled at dissepiment edges to yellowish or pale brown and distinctly thick-walled toward deep trama, frequently simple septate, occasionally branched, parallel along the tubes, (3–)3.7–6.2(–7) µm in diam. Hymenial setae rare to frequent, mostly triquetrous, sometimes ventricose, thick-walled, dark brown, hooked, 21–35 × 10–25 µm. Subhymenium indistinct; basidia barrel-shaped, with four sterigmata and a simple basal septum, (10–)10.5–

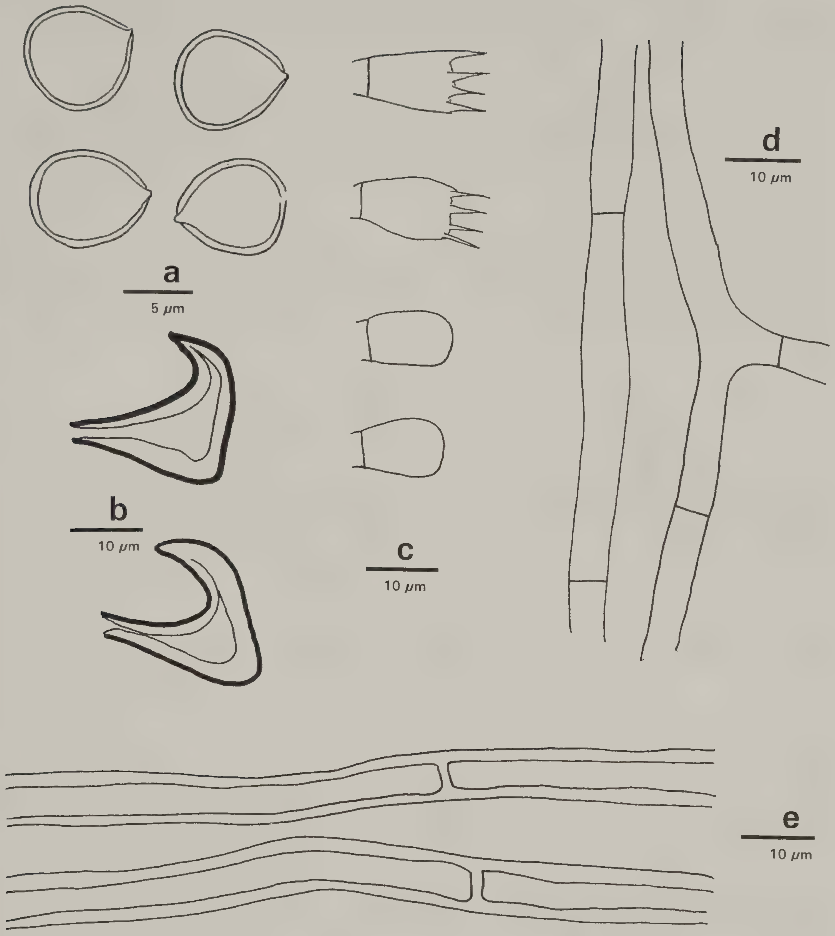
a
5 µm
b
10 µm
c
10 µm
d
10 µm
e
10 µm

Fig. 1. Microscopic structures of *Fomitiporia tibetica* Y.C. Dai & M. Zang (drawn from holotype). —a) Basidiospores. —b) Hymenial setae. —c) Basidia and basidioles. —d) Hyphae from trama. —e) Hyphae from context

15(–17) × (7.5–)8–10(–11) µm; basidioles in shape similar to basidia, but slightly smaller. Secondary mycelium occasionally present in tube cavities, hyphae of mycelium hyaline, thin-walled, frequently simple septate and branched.

*Spores.* — Basidiospores abundant, globose to ovoid, hyaline, thick-walled, smooth, dextrinoid in Melzer's reagent, strongly CB+, (6.5–)6.8–8(–8.5) × (5.5–)6–7.5(–8) µm, L = 7.53 µm, W = 6.80 µm, Q = 1.08–1.13 (spores were measured from two specimens, and 30 from each).

*Additional specimens (paratypes) examined.* — China. Sichuan Prov., Muli, on *Abies,* IX.1955 (HMAS 18719). Yunnan Prov., Zhongdian County, on *Abies*, VII.1959 *Zhu* (SWFC); *Picea*, 29.VIII.1955 (HMAS 18687). Xizang Auto. Reg. Bomi County, *Picea*, 13.IX.1976 *Zang 891* (HKAS *1891*).

## DISCUSSION

*Fomitiporia tibetica* is characterized by annual growth habit, monomitic hyphal structure, triquetrous hymenial setae, dextrinoid and cyanophilous basidiospores, and by growth on gymnosperms, especially on *Abies* and *Picea*; it is found so far in Xizang, Yunnan and Sichuan, Southwest China. The species is closely related to *Fomitiporia dryadea*, but differs in several characters. The main differences between *Fomitiporia tibetica* and *F. dryadea* are listed in Table 1.

Table 1. A comparison of *Fomitiporia tibetica* and European *F. dryadea*

| | *Fomitiporia tibetica* | *Fomitiporia dryadea* |
|---|---|---|
| Basidiocarps | Annual, upper surface cracked when dry | Perennial, upper surface uncracked |
| Tubes | Readily detachable from context, fragile | Attached to context, corky |
| Hymenial setae | Mostly triquetrous in section, always hooked | Mostly ventricose in section, straight to hooked |
| Tramal hyphae | Thin- to distinctly thick-walled | Always thin-walled |
| Hosts | *Abies* and *Picea* | *Quercus* |

In Europe and eastern North America, *Fomitiporia dryadea* usually grows on oaks. Most publications report it as an annual species, but the tubes are usually in more than one layer in the European specimens, so the species apparently has a perennial habit. In North America, the most frequent substrata were reported as *Quercus* in the east and *Abies* in the west and southwest (Gilbertson and Ryvarden, 1986). One specimen collected on *Picea* from North America was studied (Washington, Olympic Peninsula, *Picea*, 4.IX.1957 *Lowe 7993 & Gilbertson*, H). It is closer to *F. tibetica* than *F. dryadea*. Because only limited American material is at our disposal, the status of American collection from conifers in west is uncertain.

The relationship of *Fomitiporia dryadea* and *F. tibetica* is similar to that of *Fomitiporia robusta* (P. Karst.) Fiasson & Niemelä on oak and *F. hartigii* (Allesch. & Schnabl) Fiasson & Niemelä on conifers: the latter two species are quite similar, but differ in being adapted to grow on different hosts (Ryvarden and Gilbertson, 1994). Another example is the *Laetiporus sulphureus* (Bull.:Fr.) Murrill complex, which was considered as one species although it occurs both angiosperms and gymnosperms. Recently Burdsall and Banik (2001) recognized 6 species from North America based on ecology, morphology, mating tests and molecular studies. Among the American species, two species on coniferous trees, *L. conifericola* Burds. & Banik and *L. huroniensis* Burds. & Banik, are rather similar to *L. sulphureus,* but the ecology of the two species are different from *L. sulphureus sensu stricto* (Burdsall and Banik, 2001). Similar cases occur in other genera of polypores, e.g., *Skeletocutis nivea* (Jungh.) J. Keller on angiosperms and *Skeletocutis ochroalba* Niemelä on gymnosperms (Niemelä, 1985), *Onnia leporina* (Fr.) H. Jahn on *Picea* and *Onnia triquetra* (Lenz) Imazeki on *Pinus* (Ryvarden and Gilbertson, 1993). In each of these examples both species in each pair are similar in morphology, but have different ecology.

*Specimens of related species examined.* — *Fomitiporia dryadea*. Germany. Nord-Hessen, Schauenburg-Elmshagen, *Quercus*, 7.IX.1979 *Niemelä 1700* (H). Sweden. Öland, Högsrum, *Quercus*, 16.VIII.1975 *Jeppson 1051* (H). U.K. Jura, *Quercus*, (H). Kent, *Quercus*, 24.VII.1945 *Wiltshire* (H).

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# STUDIES IN NEOTROPICAL POLYPORES 16
# RUBROPORUS CARNEOPORIS GENUS & SPECIES NOVA

CLARICE LOGUERCIO-LEITE[1], LEIF RYVARDEN[2] & CLAUDIA GROPOSO[1]

1. Lab. de Micologia, Dept. de Botânica, CCB, Universidade Federal de Santa Catarina, 88090-400, Florianópolis, SC, Brazil. clleite@ccb.ufsc.br
2. Dept. of Botany, Did. of Biology, University of Oslo, Blindern, P.O. Box 1045, N-0316 Oslo 3, Norway.

## ABSTRACT

*Rubroporus carneoporis* genus & species nova is described as new. It is characterized by a red-hymenophoral basidiocarp and a dimitic hyphal system with clamped generative hyphae and sparingly branched skeleto-ligative hyphae, and ellipsoid basidiospores. It grows on *Alchornea triplinervia* (Euphorbiaceae) causing a white rot, in a subtropical area.

**KEYWORDS**: polyporoid, new genera, *Rubroporus*

## INTRODUCTION

Some time ago one of us (CLL) received a red-hymenophoral polypore specimen collected in the botanical garden belonging to the University of Santa Catarina (Brazil). Superficially it was reminiscent of an anomalous *Fistulina* Bull: Fr. species because it was extremely fleshy in fresh condition and light of weight. However, a microscopical examination immediately ruled out *Fistulina* because of numerous skeleto-ligative or arboriform thick-walled hyphae, of a type not seen in this genus.

The hyphal system of the unknown red-hymenophoral polypore was reminiscent of that seen in *Piptoporus* Karst., which, however, is a brown rot genus, while the Brazilian species clearly had a white rot species. *Polyporus* Fr. s. str. is also a genus with skeleto-ligative hyphae, but in this genus they are narrow and distinctly branched, often dichotomously with long thin and whip-like side-branches. Further, all species of this genus have tough basidiocarps with white to pale wood-coloured tubes and context, very different from the strong red colour of the new polypore, especially seen in the tubes.

A search in the universal key to polypore genera in RYVARDEN (1991) gave no reasonable generic affinity, and thus we decided it should be placed in a genus of its own.

## MATERIAL AND METHODS

Basidiomata were studied according to the methodology described by LOGUERCIO-LEITE & WRIGHT (1991). Colours are according to MUNSELL (1975) and herbaria abbreviations listed by HOLMGREN *et al.* (1990). The spores were measured with an automated Lucia Image system from a computer screen and totally 20 spores were measured. Of the measured lengths and widths, the three shortest and longest were eliminated and their extreme values are given in parentheses. The terminology used for description of the hyphae is that of PEGLER (1996).

## RESULTS

*Rubroporus carneoporis* Leite, C.L., Ryvarden & Groposo genus & species nova.

**Figure 1**

*Basidiocarpus sessilis, in vivo carneus et levis, in sicco fragilis. Pileus niveus vel rubra, margo sterilis. Hymenophorus rubrus, poris angularis, 2-4 per mm, tubulis concoloribulus usque 4.0 mm long. Systema hypharum dimiticum, hyphis fibulatis, tenui-tunicatis, 3-4 µm diam.; hyphis skeletibus-colligatis, crassi-tunicatis, leviter dextrinoideis, 5-6 (-10) µm diam. Cystidius adsunt. Basidiosporis ellipsoideis, hyalinis, levibus, tenui-tunicatis, 5-6 x 2.6-3.2 µm, inamiloideis.*
*Holotypus: Brasilia, Insula Santa Catarina, Florianópolis, Trindade, Horto Botânico (UFSC), leg. A. Andrade, 31. X 2001 in Herb. FLOR 11975 conservatus est; isotypus in O.*

**Basidiomata** pileate, dimidiate sessile, fleshy, light in weight, up to 13 cm wide and 8.5 cm long, and 3.0 cm thick at the base, upper surface glabrous, smooth to slightly tuberculate, azonate, white (8/2 2.5Y) with reddish tints (5/6 10R), margin light brown (7.5YR), sharp and entire in fresh and actively growing condition; pore surface dark red (3/6 10YR); pores angular, 2-4 per mm, tubes concolorous with pore surface, fragile when dry, up to 4.0 mm deep at the base, context brownish yellow (6/6 10YR) with numerous thin red (5/8 10YR) concentric zones, punky, up to 2 cm thick at the base, unchanged with KOH.

**Hyphal system** dimitic; generative hyphae with clamps, hyaline, thin-walled, 3-4 µm wide, skeleto-ligative hyphae or arboriform hyphae present (5-6 µm diam.), thick-walled, hyaline and weakly dextrinoid in Melzer´s reagent, sparingly branched in the upper part (Fig 1b), main stems up to 10 µm wide; in the context with long unbranched lower parts, followed up to 900 µm down from first side branch, these parts may easily in broken parts been classified as skeletal hyphae (Fig 1c), in the trama more strongly branched and narrower and apparently without a long unbranched base, which probably is the reason for the fragile tubes in contrast to the punky context.

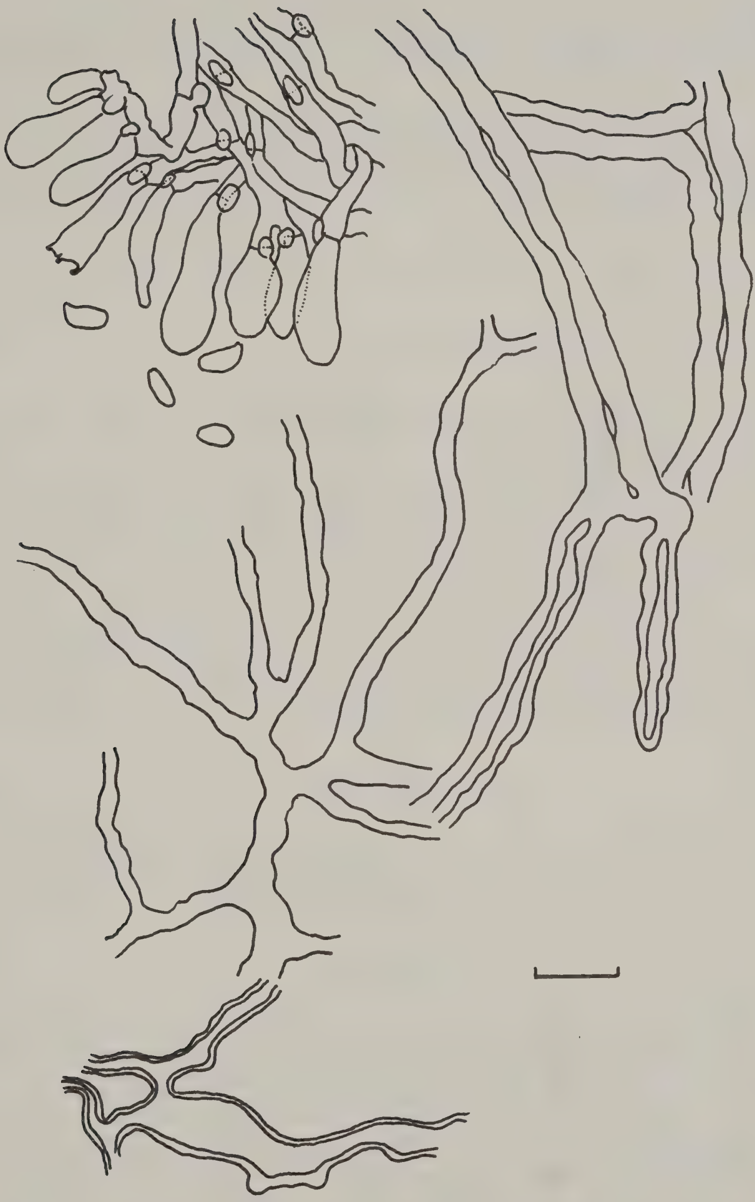

Figure 1. *Rubroporus carneoporis* (FLOR 11975). a) hymenium and basidiospores; b) skeleto-ligative hyphae from the trama, c) skeleto-ligative hyphae from the context. Scale bar =10 μm.

**Cystidia** absent.
**Basidia** clavate, 4-sterigmate, 12-18 x 4-6 µm, with a basal clamp.
**Basidiospores** ellipsoid, hyaline, smooth, (5.0) 5.2-6.1 (6.2) x (2.5) 2.6-3.2 (3.3) µm, IKI negative (Fig 1a).

**Holotype**: BRAZIL, SC, Ilha de Santa Catarina, Florianópolis, Trindade, Horto Botânico, UFSC, A. Andrade, 30/X/2001 (FLOR 11975). **Isotype** in O.
**Material examined**: BRAZIL, SC, Porto Novo, Rick 609 (No date) FH, O.

**Substrata.** Known from dead trunk of *Alchornea triplinervia* (Euphorbiaceae) causing a white rot.

**Distribution**. Known from southern Brazil.

**Remarks**. The new genus and species are above all characterized by its fleshy reddish basidiocarp and a dimitic hyphal system with sparingly branched skeleto-ligative hyphae.
The latter are slightly dextrinoid in Melzer´s reagent, a reaction which is unknown in *Polyporus* Fr. s. str. another genus with white rot and skeleto-ligative hyphae, but where all basidiocarps are tough with white or pale wood-coloured tubes and context.

Superficially *Rubroporus carneoporis* may remind one of *Hapalopilus* Karst. species, some of which have a distinct reddish colour. However, all species in this genus react with a strong cherry red colour with KOH and they all have a monomitic hyphal system. For a synopsis of this genus, see KO, JUNG & RYVARDEN (2001).

## ACKNOWLEDGMENTS

We are grateful to Mr. Amarildo Andrade who collected the holotype. Professor Nils Hallenberg, Gothenburg University has kindly acted a presubmission reviewer and his help is acknowledged.

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# MORPHOLOGICAL AND CULTURAL DIFFERENTIATION OF DESCRIBED SPECIES OF ALTERNARIA FROM POACEAE

FRANK M. DUGAN[1], USDA-ARS Western Regional Plant Introduction Station, and TOBIN L. PEEVER, Department of Plant Pathology, Washington State University, Pullman, WA 66164 USA
[1]Corresponding author, Email: fdugan@mail.wsu.edu

**Abstract**: Thirteen graminicolous species currently or previously assigned to the genus *Alternaria* are illustrated from type, authentic and/or representative cultures and exsiccati. Concise descriptions and a key to morphological characters are provided and tested against small-spored, chain-forming strains isolated by the authors. An additional eleven names for which material was unavailable, insufficient for accurate description, or of only incidental occurrence on Poaceae are listed. A small number of small-spored, chain-forming strains were poorly accommodated within the descriptions and may represent unnamed species.

Additional key words: Species concept, *Trichoconiella*.

**Introduction**:

A number of reasons support the publication of a key with descriptions for *Alternaria* species isolated from grass family hosts. Diagnosticians and regulatory officials need to recognize phytopathogenic species, especially those causing serious diseases but not yet present in all geographic areas. Significant diseases include Alternaria leaf blight (*Alternaria triticina* Prasada & Prabhu) of wheat, black point (*Alternaria* spp.) of wheat, and rice stackburn (*Trichoconiella padwickii* (Ganguly) B.L. Jain = *Alternaria padwickii* (Ganguly) M.B. Ellis), all of which can be seedborne (Agarwal and Sinclair 1997; Holliday 1989; Maude 1996). Of the above named species, *A. triticina* is not yet reported from the United States. Originally from south Asia, it has been reported from the Middle East, Nigeria, Italy and in Mexico (Wiese 1987; Zillinsky 1983). Rotem (1994) called for criteria capable of separating *A. triticina* from *A. alternata* (Fr. : Fr.) Keissl. Other *Alternaria* species not yet reported from the United States include *A. cetera* E.G. Simmons (Australia), *A. metachromatica* E.G. Simmons (Australia), *A. saparva* (Subram.) Deighton (India), *A. triticicola*

V.G. Rao (India) and *A. triticimaculans* E.G. Simmons & Perelló (Argentina). *A triticimaculans* can infect seeds and has the potential to aggressively attack certain cultivars of wheat (Perelló et al. 1996).

In addition, it is desirable to attain greater accuracy for assignment of names. Although the widespread presence of *A. infectoria* E.G. Simmons (teleomorph = *Lewia infectoria* (Fuckel) M.E. Barr & E.G. Simmons = *Pleospora infectoria* Fuckel) on cereals and grasses is well documented in taxonomic literature (Crivelli 1983; Ellis 1971; Ellis and Ellis 1985; Farr et al. 1989; Simmons 1994b; Whitehead and Dickson 1952), *A. alternata* or just *Alternata* sp. or spp. continue to be the only names applied by phytopathologists to *Alternaria* strains causing black point of wheat and barley (Fernandez et al. 2000; Johnston 1997; Murray et al. 1998) and Alternaria leaf blight (leaf spot) of maize (McGee 1988; White 1999). *A. infectoria* is commonly recovered from seeds and vegetative tissues of cereals and grasses (Dugan, unpublished data) but is not treated in Rotem (1994), the most recent review of the genus published for phytopathologists. Richardson (1990) mistakenly lists *A. alternata* as the anamorph of *Pleospora infectoria*. Strains in *A. alternata* usually produce mycotoxins in higher quantities than strains of *A. infectoria* (Andersen and Thrane 1996; Webley et al. 1997). The failure to distinguish between the two taxa compromises the accuracy and utility of many studies (Webley et al. 1997).

Another rationale for publication of a key is to advance understanding of species complexes. For the purposes of this study, we define a complex as a group of species closely resembling one another in morphological and colony characters, as well as in the production of specified metabolites. Accordingly, we write of the *A. alternata* complex, the *A. tenuissima* complex and the *A. infectoria* complex. (The *A. arborescens* complex was not encountered in our studies.) In each case, the complex is comprised of strains assignable to the species plus very similar strains of allied or potential cryptic species. The *A. infectoria* complex presently encompasses that species plus *A. metachromatica*, *A. triticimaculans* and *A. oregonensis* E.G. Simmons (Simmons 1994b). The toxigenic potential of strains recently assigned to "*A. tenuissima* groups" (Roberts et al. 2000) is similar to that of strains assigned to *A. alternata* (Andersen and Thrane 1996). Strains in the *A. infectoria* complex tend to sporulate less prolifically than those in the *A. alternata* and *A. tenuissima* complexes, produce a clumpy, granular pattern on agars weak in sugar content, and tend toward conspicuously developed false beaks (de Hoog et al. 2000; Simmons 1994b). Strains in *A. infectoria* are deficient in production of mycotoxin (Andersen and Thrane 1996; Webley et al. 1997). Within the *A. alternata*, *A. tenuissima* and *A. infectoria* species complexes, it is desirable to distinguish those strains which fall readily within the limits of published descriptions from those which do not. In this manner, morphological and cultural variation can be documented and correlated with pathological and other attributes. The primary objective of this study is the production of a morphological key for *Alternaria* species well documented on grass family hosts. In so doing, we present morphological and cultural data pertinent to the species complexes designated above.

Some of the species in our key (viz *A. longissima* Deighton & MacGarvie and *A. saparva*) may in the future prove only distantly related to *Alternaria* sensu stricto, but are included because their conidia are *Alternaria*-like and because they have been treated with *Alternaria* in mycological literature (Ellis 1971, 1976). *T. padwickii* is encountered in the phytopathological literature (Groth 1992; Nyvall 1999; Ou 1972) and mycological literature (Ellis 1971) as *Alternaria padwickii*. *A. longissima* has been recently demonstrated to be phylogenetically distant from *A. alternata* and other *Alternaria* species on the basis of 18S rDNA (Pryor and Gilbertson 2000). The ultimate taxonomic re-disposition of these *Alternaria*-like species may prove analogous to that of several "*Alternaria*" species on rushes and sedges; these species are now accommodated in *Nimbya* (Simmons 1989).

**Materials and Methods**:

Names, collection numbers, and catalogued hosts of the strains and exsiccati used for this study are given in Tables 1 & 2. Representative material isolated from grass family hosts is scarce for some taxa, so in these cases additional representative strains from hosts other than Poaceae have been employed for comparative purposes. Small-spored, chain-forming strains from the USDA-ARS Western Regional Plant Introduction Station (WRPIS) are listed in Table 3. Per recommendation of Simmons (1995, 1999), observations on living material were conducted on cultures derived from single-conidium colonies; cultures were streaked onto half strength V8 agar (Stevens 1981) for recovery of typical colonies generated by growth of single conidia. Subcultures were stored on silica gel and/or in liquid nitrogen (Smith and Onions 1994).

To avoid cross contamination, conidia generated as above were harvested into semi-liquid 0.2% water agar (Pitt 1979) for later inoculation to the centers of 4-part plastic culture plates (Falcon® X-plates$^{TM}$) which contained one compartment each of potato carrot agar (PCA, Simmons 1992), hay infusion agar (HAY, Simmons 1992), V8 juice agar (V8, Simmons 1992) and Dichloran Rose Bengal Yeast Extract Sucrose Agar (DRYES, Frisvad 1983). Inoculated plates were incubated at 20-24C (ave. 22C) thirteen inches from two side-by-side fluorescent lights (Sylvania® F20t12/CW) on a cycle of 8 hrs light / 16 hrs darkness. Additional inoculations to DRYES medium were incubated at ca. 25C in darkness (Andersen and Thrane 1996).

**Table 1: Cultures from Culture Collections**

| Name* | Collection number* | Host* |
|---|---|---|
| *Alternaria alternata* | ATCC 66981 (EGS-34-016) | *Arachis hypogaea*[†] |
| | ATCC 66983 (EGS 35-056) | *Abelmoschus moschatus*[†] |
| | ATCC 56835, ATCC 56836 | wheat grain |
| | ATCC 62097[‡] | *Zea mays* |
| | EGS 34-039 | *Datura metal*[†] |
| | EGS 35-193 | *Musa sapientum*[†] |
| *Alternaria cetera* | ATCC 200420 (EGS 41-072), ex-type | *Elymus scabrus* |
| *Alternaria infectoria* | EGS 27-193, ex-type | *Triticum aestivum* |
| *Pleospora infectoria* | ATCC 12054 (CBS 308.53)[‡] | *Avena sativa* straw |
| *Alternaria japonica* | IMI 369146 (dep. E.G. Simmons) | *Brassica pekininsis*[†] |
| *Alternaria longissima* | ATCC 18553 (IMI 115159, MacGarvie) | *Oryza sativa* husks |
| *Alternaria maritima* | IMI 081622 | wood block in sea water[¶] |
| *Alternaria metachromatica* | ATCC 96166 (EGS 38-132), ex type | *Triticum aestivum* |
| *Alternaria oregonensis* | ATCC 96163 (EGS 29-174), ex type | *Triticum aestivum* |
| *Trichoconiella padwickii* | ATCC 34394 | *Oryza sativa* seed |
| *Alternaria peglionii* | CBS 103.26[#] | not cataloged |
| *Alternaria tenuissima* | CBS 918.96 (EGS 34-015) | *Dianthus* sp.[†] |
| | CBS 965.95 | *Triticum* sp. |
| | IBT 8395, IBT 8396, IBT 8397, IBT 8398 | barley |
| | IBT 8402 | barley |
| *Alternaria tricimaculans* | ATCC 96162 (EGS 41-050), ex type | *Triticum aestivum* |
| *Alternaria triticicola* | IMI 244979 | *Triticum sativum* |
| *Alternaria triticina* | ATCC 36205 (EGS 17-061), ex-type | wheat |

* ATCC = American Type Culture Collection; CBS = Centraalbureau voor Schimmelcultures; EGS = culture collection of Emory G. Simmons; IBT = culture collection of Dept. Biotechnology, Technical Univ. of Denmark. IMI = International Mycological Institute (United Kingdom National Culture Collection); fungus and host are listed as cataloged by culture collection. [†]Host not from Poaceae. These strains were included because they are representative of the taxon. [‡]ATCC 62097: cataloged as *A. alternata* but morphologically congruent with *A. tenuissima*. CBS 308.53: cataloged as *A. infectoria* with E.G. Simmons depositor, but see Footnote 1. [¶]IMI 081622 may not be Sutherland's fungus, originally reported from algae and later from *Spartina*. [#]Failed to sporulate.

Near-ultraviolet light, efficient in promoting sporulation prior to storage, was avoided for standard incubation conditions to avoid generating greater than normal roughness in conidial walls (Simmons 1995); fluorescent lighting has been the standard recommendation for morphological studies of *Alternaria* spp. (Roberts et al. 2000; Simmons 1992). PCA, HAY and V8 are standard media recommended by Simmons (1992) for observations on cultural characters and morphology; half strength V8 (½ V8), and, rarely, potato dextrose agar (PDA) or malt extract agar (MEA) were also employed for micro-characters. DRYES was demonstrated by Anderson and Thrane (1996) to aid distinction between *Alternaria infectoria* (whitish colonies) and *A. alternata* (rusty olive-brown colonies, with various shades of yellow, brown or green in the center).

Patterns of branching of conidial chains on PCA (or, rarely, other media as noted) were observed at 40-100X and recorded photographically at 50X. Conidia mounted in 85% lactic acid were observed and photographed at 100-1000X with an Olympus C-35AD-4 camera or an Olympus DP 11 camera on an Olympus BH-2 microscope. Measurements for statistical analysis were taken from conidia in areas sporulating for 7 or more days (Simmons 1992). Seventy-five conidia of each strain were measured at 400X; widths of less than 5 µm were measured at 1000X and lengths of longer conidia (e.g. *A. longissima*) measured at 100-200X. Outliers given in parentheses were not restricted to conidia within the sample of 75. Measurements taken from exsiccati and strains deficient in sporulation necessitated reduced sample sizes as noted. Recorded lengths include any true beaks (rostra) but not false beaks (proliferated beaks, pseudorostra) sensu Neergard (1945).

The morphological key and descriptions were constructed by comparing type, representative and well authenticated cultures and exsiccati (Tables 1 & 2) in our laboratory with descriptions in the literature for *Alternaria alternata* (= *A. tenuis* Nees) (Ellis 1971; Simmons 1967, 1990a, 1995b, 1999a,b; Simmons and Roberts 1993), *A. cetera* E.G. Simmons (Simmons 1996a), *A. infectoria* (Ellis 1971; Simmons 1986, 1994b; Simmons and Roberts 1993), *A. japonica* Yoshii (= *A. raphani* J.W. Groves & Skolko) (Corlett and Corlett 1999; Ellis 1971; Simmons 1995b), *A. longissima* (Deighton and MacGarvie 1968; Ellis 1971), *A. metachromatica* and *A. oregonensis* (Simmons 1994b), *Trichoconiella padwickii* (Ellis 1971; Jain 1975), *A. saparva* (Cejp and Deighton 1969; Ellis 1976), *A. tenuissima* (Fr.) Wiltshire (Ellis 1971; Simmons 1990a, 1993, 1995b; Simmons and Roberts 1993; Wiltshire 1933), *A. triticicola* (Ellis 1976; Rao 1964; Simmons 1994b), *A. triticimaculans* (Simmons 1994b), and *A. triticina* (Ellis 1976; Prasada and Prabhu 1962; Simmons 1981). Additional synonyms for several species can be found in the authors cited or at the web site of the USDA-ARS Systematic Botany and Mycology Laboratory (http://nt.ars-grin.gov/index.htm). Additional information on strains from culture collections can be located on the web sites of the respective culture collection.

The key was tested and refined with regard to the small-spored taxa by examination of isolates from WRPIS materials (Tables 3 and 4). Small-spored, chain-forming strains were assigned to species complexes (*A. alternata*, *A. infectoria*, and *A. tenuissima*) on the basis of DRYES reaction, presence or absence of sporulation clusters on PCA, and branching patterns of conidial chains as described in the taxonomic literature cited above and in accordance with the resultant key. Then, statistical comparisons via ANOVA and Tukey's paired comparisons or least significant differences (LSD) were generated via Systat® 9 (SPSS Inc., Chicago IL) between these species complexes with regard to length and width of conidia, numbers of transverse or longitudinal septa, length of true or false beaks, and numbers of beakless conidia. Unless otherwise stated, means for beaks and false beaks include beakless conidia. Smaller sets of comparisons were generated for strains within the *A. infectoria* complex (*A. infectoria, A. metachromatica, A. oregonensis, A. triticimaculans*).

**Table 2: Exsiccati examined**

| **Name** | **Collection number** | **Host** |
|---|---|---|
| *Alternaria graminum* | K(M)[†]: 75849, type | *Bambusa*, leaves |
| *Alternaria longissima* | IMI 126971, ex type | *Oryza sativa* L. |
| *Alternaria padwickii* | IMI 126971 | *Oryza sativa* |
| | BPI US0420425* | *Oryza sativa* |
| | BPI US0420426* | *Oryza sativa* |
| *Alternaria peglionii* | BPI US 0446476, ex type* | *Triticum* var. 'Gentil rosso' |
| *Alternaria saparva* | IMI 62747, ex type | Gramineae, dead stem |
| | IMI 143234 | *Oryza sativa* |

*No conidia or sclerotia could be located on BPI US0420425 (a note in packet reads "bacterial stripe") nor on BPI US0420426; no conidia could be located on BPI US0446476 (6 seeds with slight discoloration). [†]Kew; other collections as in Table 1.

**Table 3. Strains from WRPIS:**

| WRPIS number | Name applied | Host | Colony on DRYES | Sporulation on PCA |
|---|---|---|---|---|
| 371689#1 | *A. infectoria* | *Elytrigia repens* (L.) Nevsky | flocculent, off white | clusters, long false beaks |
| 371689#67a | *A. infectoria** | *E. repens* | flocculent, off white | clusters, long false beaks |
| 372628#9 | *A. cf. tenuissima* | *Phleum pratense* L. | velutinous, rusty brown | chains up to 12, not much branched |
| 483443#10 | *A. tenuissima* | *Bromus tectorum* L. | velutinous, rusty brown | chains up to 11, ± short side chains |
| 483443#50 | *A. infectoria* | *B. tectorum* | flocculent, off white | clusters, long false beaks |
| 483443#99 | *A. tenuissima* | *B. tectorum* | velutinous, rusty brown | chains up to 12, ± short side chains |
| 564692#12 | *A. infectoria* | *Arrhenatherum elatius* (L.) J. Presl & C. Presl | flocculent white | clusters, long false beaks |
| 564692#19 | *A. infectoria* | *A. elatius* | flocculent, white | clusters, long false beaks |
| 578671#3 | *A. infectoria* | *Dactylis glomerata* L. | flocculent, white | clusters, long false beaks |
| 578671#23 | *not assigned* | *D. glomerata* | velutinous to flocculent, pale olive, becoming white | small clusters, ± long false beaks, branching pattern not distinctive |
| 578671#48 | *A. infectoria* | *D. glomerata* | flocculent, white | clusters, long false beaks |
| 578731#12 | *A. infectoria* | *Festuca idahoensis* Elmer | type C[†] | clusters, long false beaks |
| 578731#57 | *A. infectoria* | *F. idahoensis* | off white | clusters, long false beaks |
| 611150#34 | *A. cf. tenuissima* | *Pseudoroegneria spicata* (Pursh) A. Löve | velutinous, rusty brown | chains to 12(-16), ± side branches |
| KP32-00 | *A. japonica* | *Leymus cinereus* (Schribn. & Merr.) Löve | not tested | solitary or short chains (on ½ V8) |
| KP99Avf#3 | *A. cf. tenuissima* | *Avena fatua* L. | velutinous, rust brown | chains up to 11, ± short side chains |
| MH99Ac#73 | *A. infectoria?* | *Aegilops cylindrica* Host | flocculent, off white | clusters, long false beaks |
| SB99Tra#1 | *A. tenuissima* | *Triticum aestivum* L. | velutinous, rust brown | chains up to 12, ± short side chains |
| SB99Tra#5 | *A. infectoria* | *T. aestivum* | flocculent, off white | clusters, long false beaks |
| SB99Tra#32 | *A. infectoria** | *T. aestivum* | flocculent, off white | clusters, long false beaks |
| SM99Brt#3 | *A. infectoria** | *B. tectorum* | flocculent, off white | clusters, long false beaks |
| WA8-99 | *A. infectoria* | *Agropyron cristatum* (L.) Gaertn. | type C | clusters, long false beaks |

*Would key to *A. oregonensis* based on maximum conidial length. See Table 5.

[†] type C colony: velutinous, medium to pale olive, with thin, white, flocculent mycelial overlay; off white in 24 hr darkness.

**Results:**

**Descriptions based on strains and exsiccati from collections:**

***Alternaria alternata* (Fr. : Fr.) Keissl.** (Figs. 1 & 2). Conidia from PCA at seven days (7-)9-43(-50.5) x (5-)6-14(-15) µm, (averaging 19.5-23.5 x 8.5-10 µm), with 0-7 (averaging 2-2.6) transverse septa and 0-3 (averaging 0.5-0.6) cellular compartments with longitudinal septa, verruculose to verrucose, with surface ornamentation sometimes rendering septa somewhat obscure, golden brown with beaks ('rostra') more pale than body, beaks up to 13 µm (averaging 3-4 µm) (Fig. 1, Table 4). Conidiophores typically 25-110 x 3.5-4(-5) µm, 0-1 branched, septate, smooth, concolorous with or slightly darker than conidia, geniculate, with 1-3(-5) conidiogenous loci per branch. Secondary conidiophores from conidia arise either as short proliferated beaks (false beaks, averaging 1-3.5(-7) µm) or frequently from sides or proximal ends of conidia. Conidiophores from agar surface produce sporulation patterns consisting of short, frequently branched chains typically < 10 conidia in length (Fig. 2). Colony on DRYES: velutinous, typically sulcate, deep rust brown with olive margin. Sporulation on PCA blackish olive, in concentric zones, with no or little granular pattern. Strains examined: ATCC (American Type Culture Collection) 66981 (= EGS (Emory G. Simmons) 34-016), ATCC 66983 (= EGS 35-056), ATCC 56835, ATCC 56836, EGS 34-039, EGS 35-193.

***Alternaria cetera* E.G. Simmons** (Fig. 3). Conidia on PCA at 7 days 9.5-39(-41.5) x 2.5-5 µm (mean of 20.5 x 3.5 µm), non-alternarioid, medium golden brown, lighter toward ends and near septa, smooth, cylindrical, with 0-4(-5) (mean of 0.9) transepta; some conidia possessing a distinctly beak-like apex. Conidiophores often from aggregations of hyphae ("ropes"), and commonly 7-34 x 3-5(-5) µm, smooth, colored as conidia. Colony on DRYES, low flocculent, dirty gray with off-white margin. Sporulation on PCA, deep olive green, low flocculent, concentrically zoned (but less than on V8 and HAY) and faintly striate. Strain examined: ATCC 200420 (= EGS 41-072), ex type.

***Alternaria infectoria* E.G. Simmons** (Figs. 4,5). Conidia from PCA at 7 days (8-)10.5-40.5(-49) x 5.5-13.5 µm (mean of 21.5 x 8 µm), verruculose to verrucose, golden brown, with 0-9 (mean of 2.8) transverse septa and 0-3 (mean of 0.5) cellular compartments with longitudinal septa, beaks up to11 µm (mean of 3.5 µm) (Fig. 4, Tables 4,5). Conidiophores usually 25-115 x 3.5-5 µm, 0-1 branched, smooth, concolorous with conidia, septate, geniculate, with 1-4(-5) conidiogenous loci per branch. Conidia often beakless or with long proliferating beaks (false beaks, secondary conidophores) averaging 19.5 µm, and much less frequently with secondary conidiophores from sides or proximal ends. Colonies on DRYES, flocculent, off-white. Sporulation on PCA olive black to dark olive, with macroscopic sporulation clusters imparting a granular look to the colony in EGS 27-193.

Strain examined: EGS 27-193 ex type; ATCC 12054 conidial *Pleospora infectoria* Fuckel (= CBS 308.53, dep. E.G. Simmons(?)) was examined but excluded; see Footnote 1).

***Alternaria japonica*** **Yoshii** (Figs. 6,7). Conidia on V8 (24-)31-73(-78.5) x (12.5-)17-26.5 µm (means of 46-47.5 x 18.5-19.5 µm, n = 20), with 2-8 (means of 4.7-4.9) transverse septa and 2-5 (means of 2-3.6) cellular compartments with longitudinal septa, minutely verruculose, golden brown, commonly beakless or with beaks 0-19 µm (means of 3.5-5.5 µm) and conspicuously irregular in outline and/or with one or more inflated cells (Fig. 6). Conidiophores usually 20-110 x 4-7 µm, 0-1 branched, septate, smooth, more pale than conidia, occasionally geniculate, with 1-2 loci per branch. Conidia arranged singly or in short chains, and accompanied by chains of chlamydospores (Fig. 7). Strains examined: KP32-00 from *Leymus cinereus*, Klemgard Park, Whitman Co, WA; IMI 369146 from *Brassica pekinensis*, New Zealand, dep. E.G. Simmons.

***Alternaria longissima*** **Deighton & MacGarvie** (Figs. 8a,b). Sporulated poorly and intermittently on ½V8. Present were small numbers of straw-colored, narrow, subcylindric conidia with filiform beaks as described by Ellis (1971): a basal, subcylindric portion of a few to several cells and a very long, narrow, septate beak, the whole (with beak) up to 500 x 4-17 (2.5 at apex) µm. Conidia from ½ V8 at 7 days (22.5-)26.5-424(-458) x 7-18 µm (mean of 171.5 x 12.5, n = 25), smooth, straw yellow, the shorter conidia invariably beakless; conidia with 1-10 transverse septa (mean of 5.7 ) and 0-1 (mean 0.1) longitudinal septa in the body, and 0-12 (mean of 3.4) transverse septa in the beak (Figs. 8a,b). Single or, rarely, in chains of 2 (-3). Conidiophores on ½V8 commonly 85-275 x 3.5-5 µm, 0-1 branched, usually with 1(-2) conidiogenous loci. Also present were very small numbers of non-alternarioid, cylindrical, 0-2(-3)septate conidia approximately 15-40 x 5.5-8.5 µm. Strain examined: ATCC 18553 (= IMI 115159 dep. MacGarvie).

***Alternaria metachromatica*** **E.G. Simmons** (Figs. 9,10). Conidia from PCA at 7 days (10-)12.5-55.5(-64)((-73.5)) x (5.5-)7-14(-17) µm (mean 27.5 x 9.5), verrucose, dull rose to pink (light blue in water), beaks often proliferating (Fig. 9). Conidia with 0-6(-9) transverse septa (mean 2.8) and 0-3(-6) (mean 0.3) cellular compartments with longitudinal septa. In chains up to 7(-9) with side branches of 1-3 (Fig. 9). Conidiophores commonly 40-160 x 4-5 µm, muted rose-gray in lactic acid, 0-4 branches, ± geniculate, usually with 1-3 conidiogenous loci. Colony on DRYES, flocculent, white. Sporulation clusters (Fig. 10) pale bluish-gray on PCA (sporulation clusters much more dense on V8 and HAY). Strain examined: ATCC 96166 (EGS 38-132) ex type.

***Alternaria oregonensis*** **E.G. Simmons** (Figs. 11,12). Conidia from PCA at 7 days (11-)13.5-52(-63) x 5.5-15.5(-19.5) µm, (mean of 27 x 10), minutely verruculose to verrucose, golden brown, often with proliferating beaks (Fig. 11). Conidia had (0-)1-7(-9) (mean 3.1) transepta and 0-6 (mean 1.2) cellular compartments with longitudinal septa. In chains of 4-7, almost always with side chains of 1-3. Conidiophores commonly 35-120 x 4-5.5 µm, colored as conidia, sometimes 2-3 branched, ± geniculate, with up to 6 conidiogenous loci per branch. Colony on DRYES, flocculent, dirty cream with hint of olive gray at margin. Sporulation on PCA very dark olive, in concentric zones, granular due to sporulation clusters (Fig. 12). Strain examined: ATCC 96163 (= EGS 29-174) ex type.

***Trichoconiella padwickii* (Ganguly) B.L. Jain** (= *Alternaria padwickii* (Ganguly) M.B. Ellis) (Figs. 13,14a-c). Our available living material was nonsporulating on agar media, but sub-spherical, dark brown sclerotia (Fig. 13) produced on potato dextrose agar match those described and illustrated by Ellis (1971). Preserved conidia produced *in planta* were smooth to minutely echinulate and long-beaked (Fig. 14a-c). All were within the limits of the description given by Ellis (1971): 95-170 x 11-20 µm, most commonly 4 transverse septa in body with 0-1(2) septa in beak. Material examined: Exsiccatus IMI 126971, strain ATCC 34394.

***Alternaria saparva* (Subram.) Deighton** (Figs. 15a,b, 16). Present were small numbers of smooth, subhyaline, filiform conidia (Fig. 15a,b), all falling within the limits of the description by Ellis (1976): 150-300 x 8-15 (2-4 in beak) µm. Conidiophores aggregated into synnemata (Fig. 16) are conveniently diagnostic for material examined *in planta*. Material examined: Exsiccatus IMI 62747, ex type, and exsiccatus IMI 143234.

***Alternaria tenuissima* (Fr.) Wiltshire** (Figs. 17,18,19). Conidia from PCA at 7 days (7.5-)9.5-69.5(-88) x 5.5-18 µm (averaging 23.5-32.5 x 9-12.5 µm), with 0-8 (averaging 3.1-4) transverse septa which are sometimes partially obscured by surface ornamentation and with the median septum occasionally thickened and with constrictions at outer wall (Fig. 17), and with 0-4 (averaging 0.4-1.4) cellular compartments with longitudinal septa, verruculose to verrucose, golden brown, and with beaks 0-28(-44) µm (averaging 3.5-7 µm) long (Fig. 18, Table 7). Conidiophores usually 25-120(-140) x 3.5-5.5 µm, 0(-1) branched, septate, smooth, concolorous with conidia, geniculate when branched, with 1-3(-4) loci per branch. Secondary conidiophores from conidia infrequent. Conidiophores from agar surface commonly producing long, infrequently branched chains of 8-12(+) conidia (Fig. 19). Colony on DRYES variable depending on strain: generally flocculent, dirty ochre with gray-olive margin; or rusty brown to ochre and velutinous (Table 7). Sporulation on PCA olive black, faint to strong concentric zones, rarely striate, not granular. Strains examined: ATCC 60297 (cataloged by ATCC as *A. alternata*), CBS 918.96 (= EGS 34-015), CBS 965.95, IBT 8395, IBT 8396, IBT 8397, IBT 8398 and IBT 8402.

***Alternaria triticicola* V.G. Rao** [as '*triticola*'; *re* Index of Fungi 3:296] (Fig. 20). Conidia on PCA at 7 days (38.5-) 55-190(-236)((-265)) x (11-)14-25(-27.5) µm (mean of 122 x 19), straw yellow to light golden brown, smooth, with (2-)3-10(-13) (mean of 7.1) transverse septa and 0-5(-6) (mean of 1.9) cellular compartments with longitudinal septa in the body and 0-7 (mean of 2.6) transverse septa in the beak (Fig. 20), single or in short chains. Also present are very small numbers of cylindrical, 0-3 septate conidia, ca. 25-100 x 10-11 µm. Conidiophores commonly (70-)95-160(-205) x 7-8.5 µm, colored as conidia, very seldom branched, usually with a single locus at apex. Colony on DRYES irregularly flocculent and white to velutinous and ochre/olive. Sporulation on PCA sparse, translucent light olive to olive brown, slightly zoned. Strain examined: IMI 244979.

***Alternaria triticimaculans* E.G. Simmons & Perelló** (Figs. 21,22). Conidia from PCA at 7 days ((7-))(10-)18-56(-68.5)((-84)) x (5-)6.5-14.5(-17) µm (mean of 32.5 x 11), minutely verruculose to verrucose, golden brown, often with proliferating beaks. Conidia with 1-8(-10) (mean of 4.0) transverse septa and 0-6(-7) (mean of 1.1) compartments with longitudinal septa, and in chains of 3-6, commonly with side chains of 1-3 (Fig. 21). Conidiophores commonly 40-125 x 4-5 µm, colored as conidia, usually 1-3 branched, ± geniculate with 1-3 loci. Colony on DRYES, flocculent, white with hint of ochre. Sporulation dark olive, slightly zoned, striate, slightly granular where sporulation clusters (Fig 22) present (clusters much more dense on V8 and HAY). Strain examined: ATCC 96162 (EGS 41-050), ex type.

***Alternaria triticina* Prasada & Prabhu** (Figs. 23,24). Conidia on PCA at 7 days (20-)22.5-67.5(-72) x (8.5-)11-19(-21) µm (mean 36.5 x 14.5 ), smooth to verruculose, rarely verrucose, golden brown, with ≥ 50% of conidia beakless (Fig 23), and a readily detectable minority of conidia curved in "dog leg" fashion (Fig. 24). Conidia with (2-)3-7(-9) (mean of 4.4) transverse septa and (0-)1-5(-7) (mean of 2.7) compartments with longitudinal septa. In short chains of up to 3 with branches of 1-2 conidia, sometimes single. Conidiophores usually 20-110 x 3.5-5 µm, seldom branched, septate, smooth, somewhat lighter in color than conidia, seldom geniculate, 1(-2) loci. Colony on DRYES white, flocculent. Sporulation on PCA poor (but see Simmons (1994b)) and in very short, branched chains. Strain examined: ATCC 36205 (= EGS 17-061) ex-type.

**Small-spored, chain-forming strains from USDA-ARS WRPIS:**

The strains, hosts and principal characters are listed in Table 3. Strains producing flocculent whitish colonies on DRYES invariably produced sporulation patterns and conidial characters congruent with assignment to the *A. infectoria* complex (Table 3). Strains producing rusty brown colonies on DRYES were not in strict conformity to *A. alternata* sensu Simmons (e.g., Simmons 1981, 1995b; Simmons and Roberts 1993). Most were assigned to *A. tenuissima* sensu Simmons (e.g., Simmons 1981, 1995b; Simmons and Roberts 1993). Nearly all produced relatively long chains (commonly up to10-12 conidia), sometimes with sparse, short (1-4 conidia) side chains (Table 3). Many of these *A. tenuissima* strains also produced a small minority of larger conidia with an attenuated (elongated) shape, long true beaks, and dark, thickened median septa at which the outer walls were constricted.

## Statistical Tests

EGS 17-061, ex-type culture of *A. triticina,* possessed significantly longer ($P \leq 0.016$) and wider ($P \leq 0.000$) conidia than those strains closest to it in length and width: ATCC 96162 & 564692#19 (strains in the *A. infectoria* complex) and IBT 8398 & ATCC 62097 (strains within the *A. tenuissima* complex). Conidial size, especially width, enabled distinction of *A. triticina* from other small-spored, chain-forming species (Fig. 25).

When small-spored, chain-forming strains from WRPIS and culture collections (Tables 1 & 3) were assigned to the *A. alternata*, *A. tenuissima* or *A. infectoria* complexes by the morphological and cultural criteria specified in our descriptions, overall means between the three complexes differed ($P \leq 0.01$) for conidial length and width, number of transverse septa & number of cellular compartments bearing longitudinal septa, fraction of conidia bearing true beaks, and length of false beaks (Table 4). Strains belonging to the *A. alternata* complex significantly differed from strains in the *A. infectoria* complex in all respects except mean length of true beaks and mean proportion of conidia bearing false beaks (Table 4). Although the three complexes could be discerned to differ significantly with regard to overall means for several conidial characters, the complexes were not necessarily separated by discontinuities in these same characters, i.e., there was overlap of means of individual strains belonging to different complexes: For example, ATCC 66981 (= EGS 34-016, representative *A. alternata*) had a mean conidial length of 23.3 μm whereas EGS 27-193, type of *A. infectoria*, had a mean of 21.7 μm, low in comparison to all but two of the WRPIS strains assigned to the *A. infectoria* complex. *A. infectoria* complex member ATCC 12054 (= CBS 308.53)[1] had a mean length of 30.5 μm, greater than means of most *A. tenuissima* strains (Tables 4 & 7).

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[1] Although a *bone fide* member of the *A. infectoria* complex, and although keying to *A. infectoria* on the basis of maximum conidial length, ATCC 12054 is atypical for that species, primarily because of the high means for conidium length and number of transverse septa. Catalog documentation of CBS 308.53 listing E.G. Simmons as depositor could not be verified. Simmons has not designated this strain as representative of *A. infectoria* and thinks it not that species (E.G. Simmons, personal commun.).

Likewise, the overall mean for fraction of conidia with true beaks was relatively low for those strains producing the DRYES reactions diagnostic for membership in the *A. infectoria* complex (Table 3 and Fig. 26), and this mean was significantly ($P \leq 0.01$) lower than the overall means for strains producing the other reactions (Table 4). However, there was some overlap of means of individual strains with regard to fraction of conidia with true beaks, e.g., MH99Ac#73, which exhibited *A. infectoria* characters on DRYES and PCA, and had long false beaks, but this strain also had a high proportion of beaked conidia (Fig. 27). Similarly, members of the *A. infectoria* complex displayed a significantly ($P \leq 0.01$) greater overall mean for length of false beaks than members of the *A. alternata* and *A. tenuissima* complexes (Table 4), but there was overlap of means for individual strains belonging to different complexes (data not shown). So, although the overall means of characters statistically differed, the lack of absolute discontinuities with respect to strain means for conidial length and other characters precluded using quantitative attributes of these characters as breakpoints in the key.

All cataloged (culture collection) strains of the *A. infectoria* complex keyed to the cataloged name on the basis of maximum conidium length (or, in the case of *A. metachromatica*, color), as congruent with maxima in Simmons (1994b). Strains from the WRPIS collection keyed to *A. infectoria* or to *A. oregonensis* (Table 6). But within the *A. infectoria* complex, no statistically significant discontinuities are found in multiple pairwise comparisons of length means of representative strains with Tukey's HSD (Table 5). Similarly, no strains or groups of strains within the *A. infectoria* complex were isolated by statistically significant ($P \leq 0.1$) discontinuities with regard to numbers of transverse septa or compartments with longitudinal septa (data not shown).

**Key to graminicolous *Alternaria* species plus *T. padwickii***

1a. Conidia on V8 or PCA exclusively cylindrical to sub-cylindrical ........
........................................................... *Alternaria cetera**
1b. Conidia on the above media not so shaped ; beak in some species may slightly exceed the length of conidium body ................................ 2
1c. Beak often several times the length of the conidium body) .............. 9

2a. Conidia are blue in distilled water and pinkish in lactic acid
........................................................... *A. metachromatica**
(one species in the *A. infectoria* complex; the remainder keyed below)
2b. Conidia not blue in distilled water nor pink in lactic acid ................ 3

3a. Conidia often entirely beakless *and* many other conidia with long false beaks often ≥ than the length of the conidium and proliferating as secondary conidiophores .......(remainder of *A. infectoria* complex) ..8
3b. Conidia not frequently beakless *or* if so, *not* accompanied by other conidia possessing long false beaks .......................................... 4

4a. Conidia often with conspicuously elongated, filiform true beaks, sclerotia often present ......................................*Trichoconiella padwickii*
4b. Conidia often with short to elongated (but not fililform) beaks ......... 5

5a. Conidia plus true beak often ≥ 100 µm ..................... *A. triticicola*
5b. Conidia plus true beak shorter .............................................. 6

6a. Conidia solitary or in short chains of 2-4, often beakless; a readily detectable minority of conidia conspicuously curved ("dog-leg") in shape ....................................................................... *A. triticina**
6b. Conidia typically distorted in outline and with swollen cells ............. ........................................................................ *A. japonica*†
6c. Conidia in long branched or unbranched chains; conidia not curved nor distorted with swollen cells ................................................... 7

7a. Conidia on agar media in long, seldom-branched chains.................. ........................................................... *A. tenuissima* complex
7b. Conidia on agar media in short, frequently branched chains .... ......... ........................................................... *A. alternata* complex
7c. Conidia inconsistent with 7a or 7b......................................... ............... unnamed strains in *A. alternata* or *A. tenuissima* complexes

8a. Conidia (with true beak) up to 58 µm long on PCA ........ *A. infectoria*
8b. Conidia (with true beak) up to 63 µm long on P........... *A. oregonensis**
8c. Conidia (with true beak) up to 70 µm long on PCA ... *A. triticimaculans**
8d. Conidia not consistent with 8a-c.. unnamed *A. infectoria* complex strains

9a. Conidiophores on host aggregated into synnemata .............. *A. saparva*
9b. Conidiophores on host not aggregated into synnemata, chlamydospores sometimes present .............................................. *A. longissima*

*Denotes names infrequently recorded, or, in the case of *A. triticina*, potentially misapplied. See Discussion.
†Denotes taxa infrequently recorded from Poaceae but common on other hosts.

**Omitted:**

***A. brassicae*** (Berk.) Sacc. – a common and distinctive species rarely reported from grass family hosts (*Zea*, Farr et al. (1989); *Hordeum vulgare* and *Avena sativa* in Clear et al. (2000a,b respectively); on rye in Bruce et al. (1984)). The strains recently isolated by Clear et al. (2000ab) were not conserved and hence could not be obtained by us.

***A. brassicicola*** (Schwein.) Wiltshire – reported from wheat, barley and rye (Bruce et al. 1984).

***A. brevispora*** T.Y. Zhang – from *Triticum aestivum*, Shaanxi Province; specimen unavailable. The conidia as illustrated appear uniquely obpyriform (as opposed to obclavate). Some have thickened, transverse septa near the middle of the spore (Zhang 1999).

***A. cheiranthi*** (Lib.) P.C. Bolle – on wheat (Bruce et al. 1984).

***A. citri*** Ellis & N. Pierce – on wheat (Bruce et al. 1984).

***A. flagelloidea*** (G.F. Atk.) Luttr. – reported twice from *Panicum* species. Luttrell (1955) studied the only collection he could locate, the type. It contained only a few conidia which sometimes displayed branched beaks.

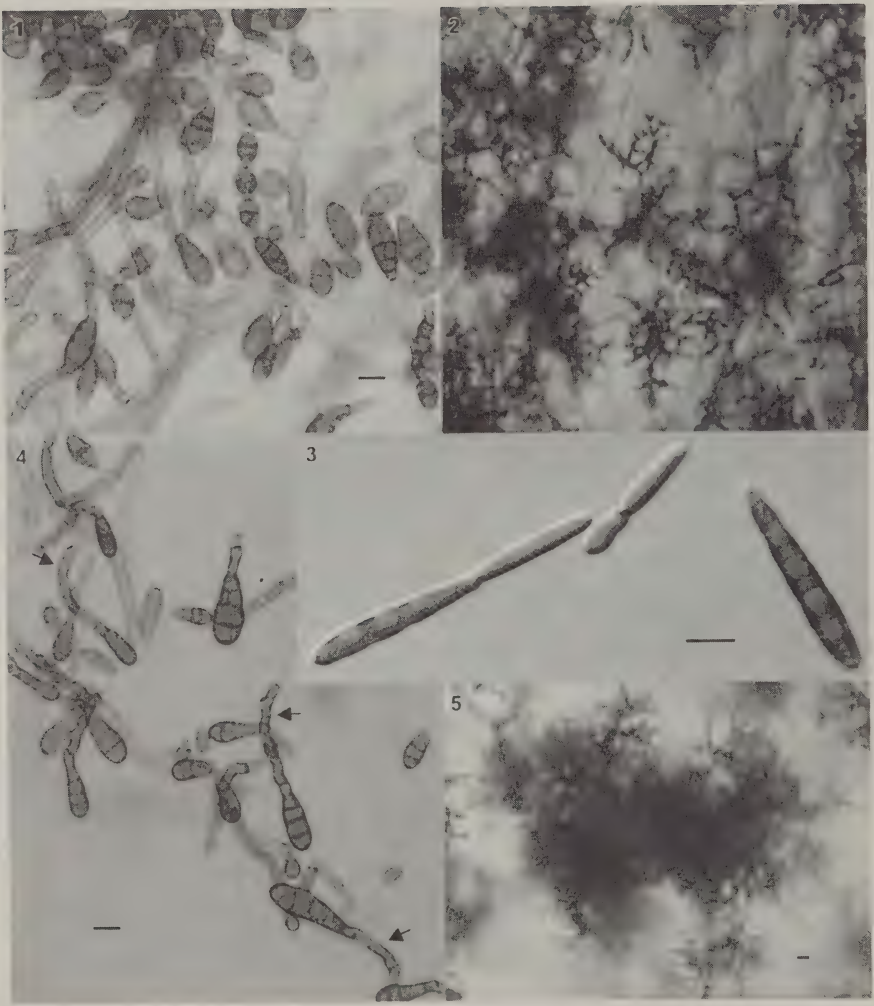
***A. graminum*** (Cooke) P. Joly – from bamboo. Cooke's original description (*Macrosporium graminum* Cooke, Anon. 1889) is very spare, and Joly (1964) even more so. There is little in the description to distinguish it from other small-spored *Alternaria* species. Type exsiccati from Kew had few conidia and no chains could be seen; a small-spored *Alternaria* resembling *A. alternata* or *A. tenuissima*.

***A. maritima*** G.K. Sutherland – Reported from *Spartina* in the United States (Farr et al. 1989), the only material we could obtain is an *Alternaria* from wood blocks immersed in sea water (IMI 81622). The name of the strain has been changed to *A. alternata* by IMI, although it looks to us like a member of the *A. infectoria* complex. IMI has not been able to locate type material (John David, personal commun.), originally described from algae (Sutherland 1916).

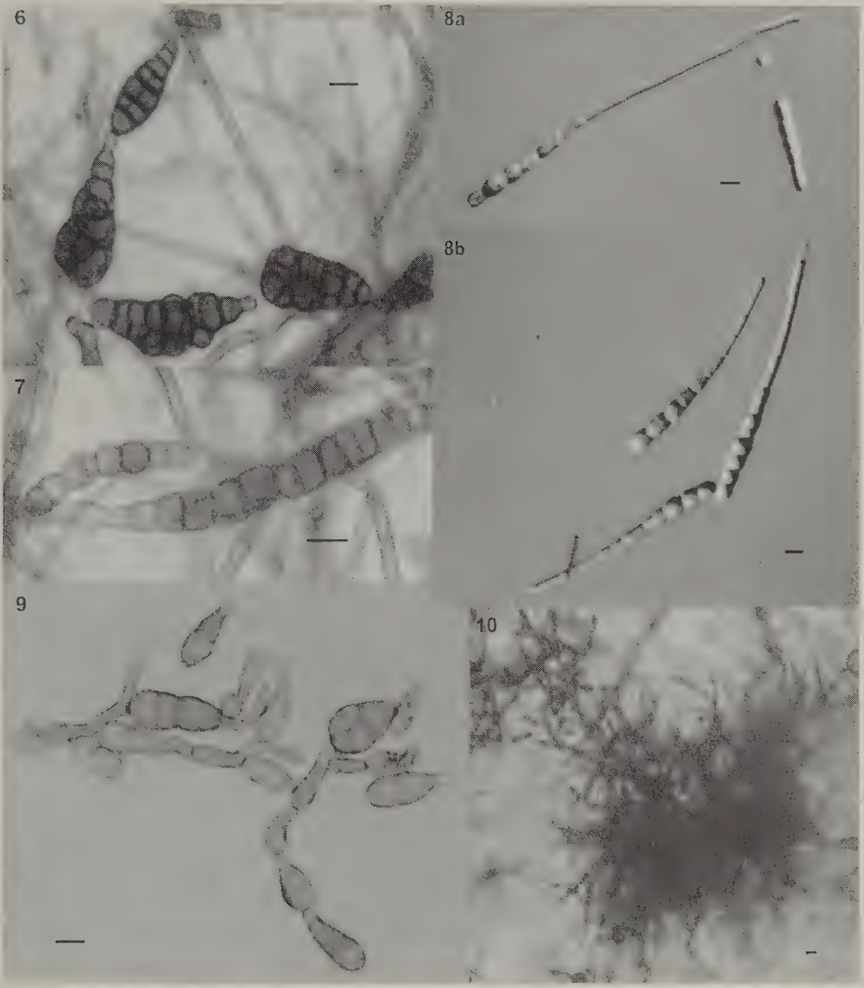
***A. oryzae*** Hara – from *Oryza sativa*, Manchuria; specimen unavailable. Hara (1928) described (in Japanese) conidia as 40-52 x 9-15 µm and conidiophores as 66-100 x 4-5 µm (John David, personal commun.).

***A. peglionii*** Curzi - ex type from BPI (on wheat seed) contained no conidia. CBS 103.26, deposited by Curzi, could not be induced to sporulate.

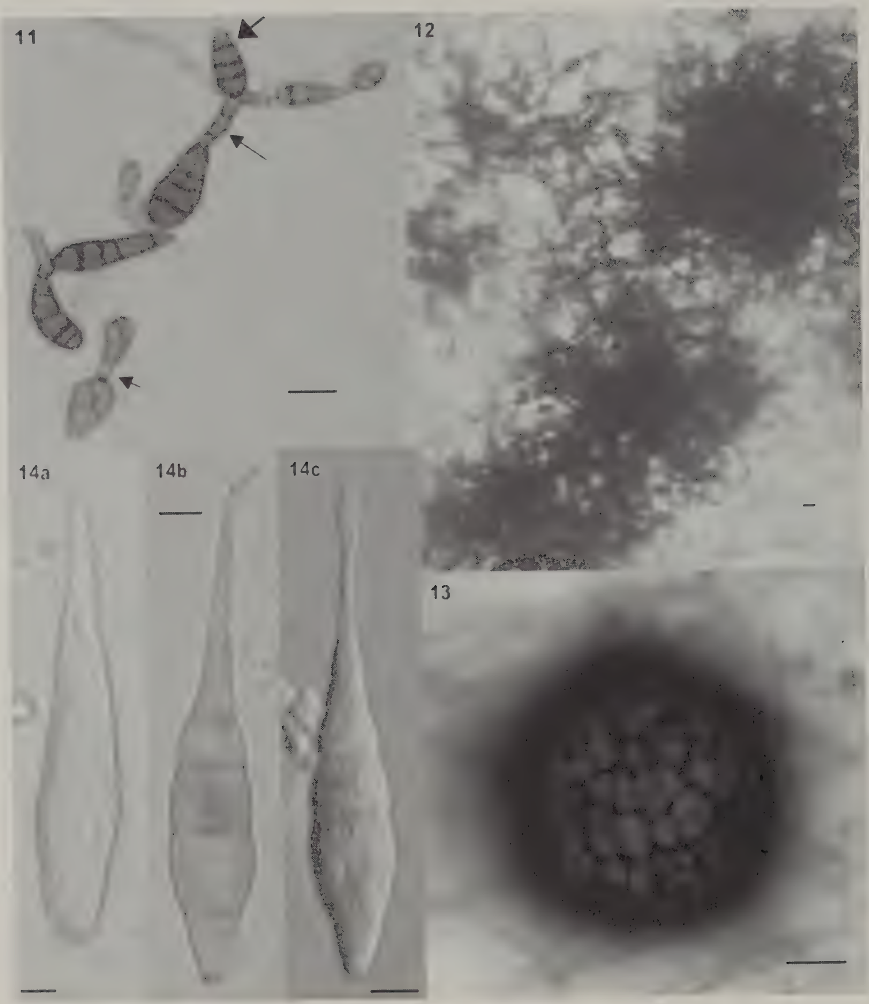
***A. setariae*** T.Y. Zhang - from *Setaria italica*, Shaanxi Province; specimen unavailable. The conidia are illustrated with beaks dramatically elongated (up to three or more times the length of the spore body) and with occasional constrictions at one of the middle, thickened transverse septa. Zhang (1999) compares this species to *A. triticina*, but results of our research with ex-type material of *A. triticina* are congruent with the opinion of Emory Simmons (personal commun.) that strong resemblance is lacking.



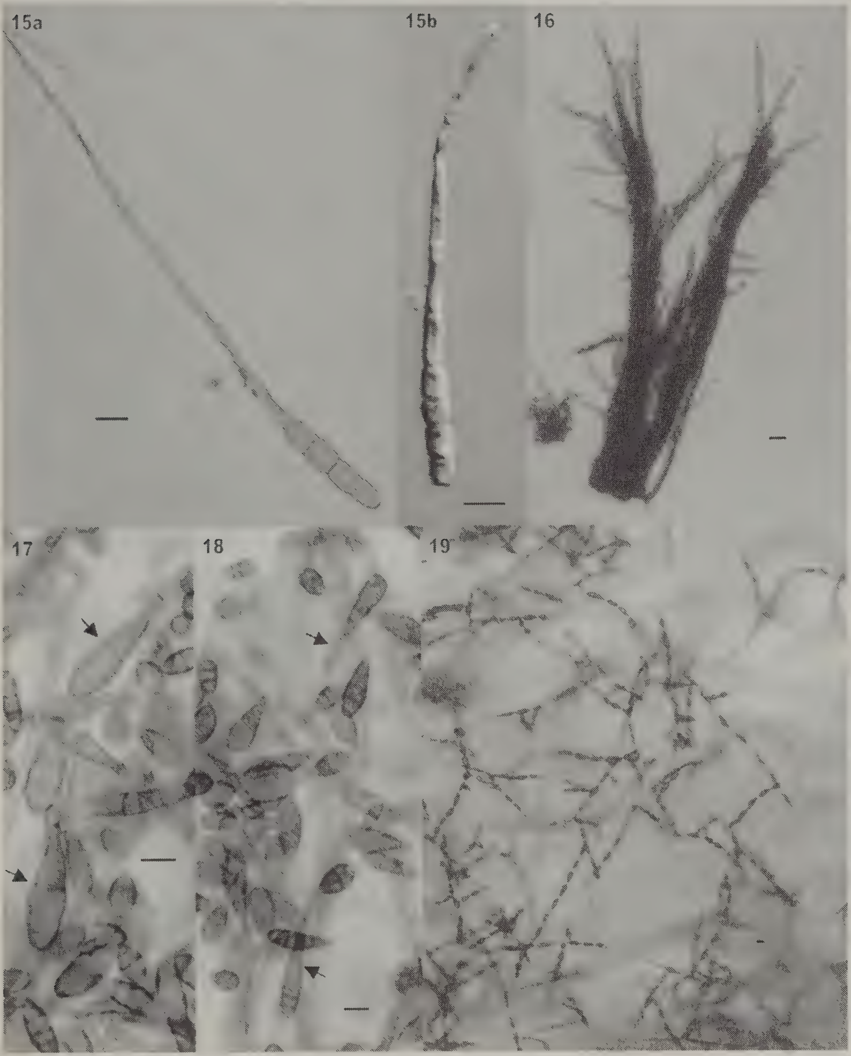
FIGS. 1-5. Figs. 1,2. *Alternaria alternata*. ATCC 56836. Fig. 1. Conidia, 7 days on PCA. Bar = 10 µm. Fig. 2. Sporulation pattern on ½ V8. Bar = 20 µm. Fig. 3. *Alternaria cetera* ATCC 200420. Conidia on ½ V8. Bar = 5 µm. Figs. 4,5. *Alternaria infectoria* EGS 27-193. Fig. 4. Conidia with long false beaks (arrows) from PCA. Bar = 10 µm. Fig. 5. Sporulation cluster on PCA. Bar = 20 µm.



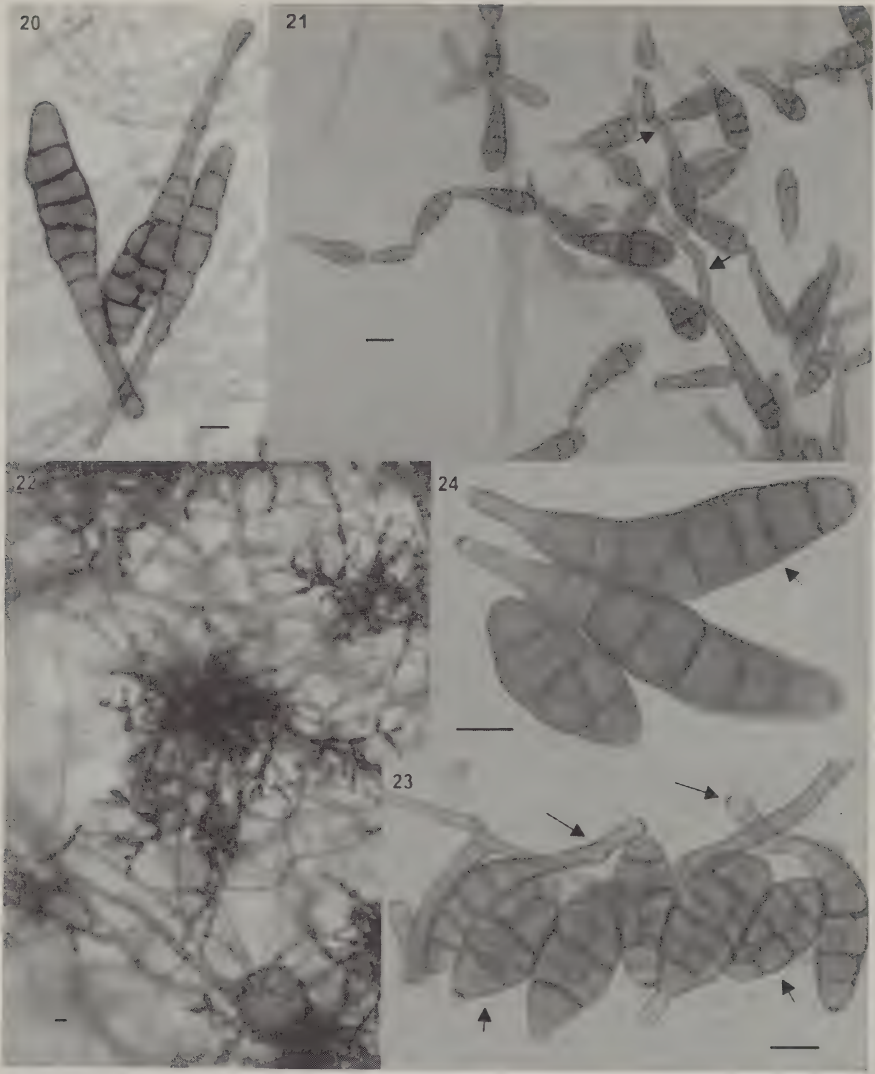
FIGS. 6-10. Figs. 6,7. *Alternaria japonica* KP32-00. Fig. 6. Conidia irregular in outline and with swollen cells. Bar = 10 µm. Fig. 7. Chains of chlamydospores. Bar = 10 µm. Figs. 8a,b. *Alternaria longissima* ATCC 18553. Beaked and beakless conidia on ½V8. Bars = 10 µm. Figs. 9,10. *Alternaria metachromatica* ATCC 96166. Fig. 9. Conidia on PCA. Bar = 10 µm. Fig. 10. Sporulation cluster on PCA. Bar = 20 µm.



FIGS. 11-14. Figs. 11-12. *Alternaria oregonensis* ATCC 96163. Fig. 11. Conidia with false beaks (long arrow), true beaks only (short arrow) and beakless conidia (wide arrow). Bar = 10 µm. Fig. 12. Typical sporulation clusters on PCA. Bar = 20 µm. Figs. 13,14. *Trichoconiella padwickii*. Fig. 13. ATCC 34394. Sclerotium on potato dextrose agar. Bar = 10 µm. Fig. 14a-c. IMI 126971. Conidia a. Bar = 5 µm; b,c. Bar = 10 µm.



FIGS. 15-19. Figs 15,16. *Alternaria saparva*. IMI 62747. Fig. 15a,b. Conidia. Bars = 10 µm. Fig. 16. Conidiophores aggregated into synnemata. Bar = 10 µm. Figs. 17,18,19. *Alternaria tenuissima*. Fig. 17. IBT 8396. Larger conidia sometimes display dark, median septa at which out walls are constricted (arrows). Bar = 10 µm. Fig. 18. CBS 965.95. Conidia with long beaks (arrows). Bar = 10 µm. Fig. 19. CBS 965.95. Long, relatively unbranched chains of conidia. Bar = 20 µm.



FIGS. 20-24. Fig. 20. *Alternaria triticicola* IMI 244979. Conidia on PCA. Bar = 10 µm. Figs. 21,22. *Alternaria triticimaculans* ATCC 96162. Fig. 21. Chains of conidia from PCA showing long false beaks (arrows). Bar = 10 µm. Fig. 22. Sporulation clusters on PCA. Bar = 20 µm. Figs. 23, 24. *Alternaria triticina* EGS 17-061. Fig. 23. Typical beakless conidia (short arrows), on PCA, flanked by two conidia with proliferated (false) beaks (long arrows). Fig. 24. Conidia, including "dog leg" conidium (arrow). Bars = 10 µm.

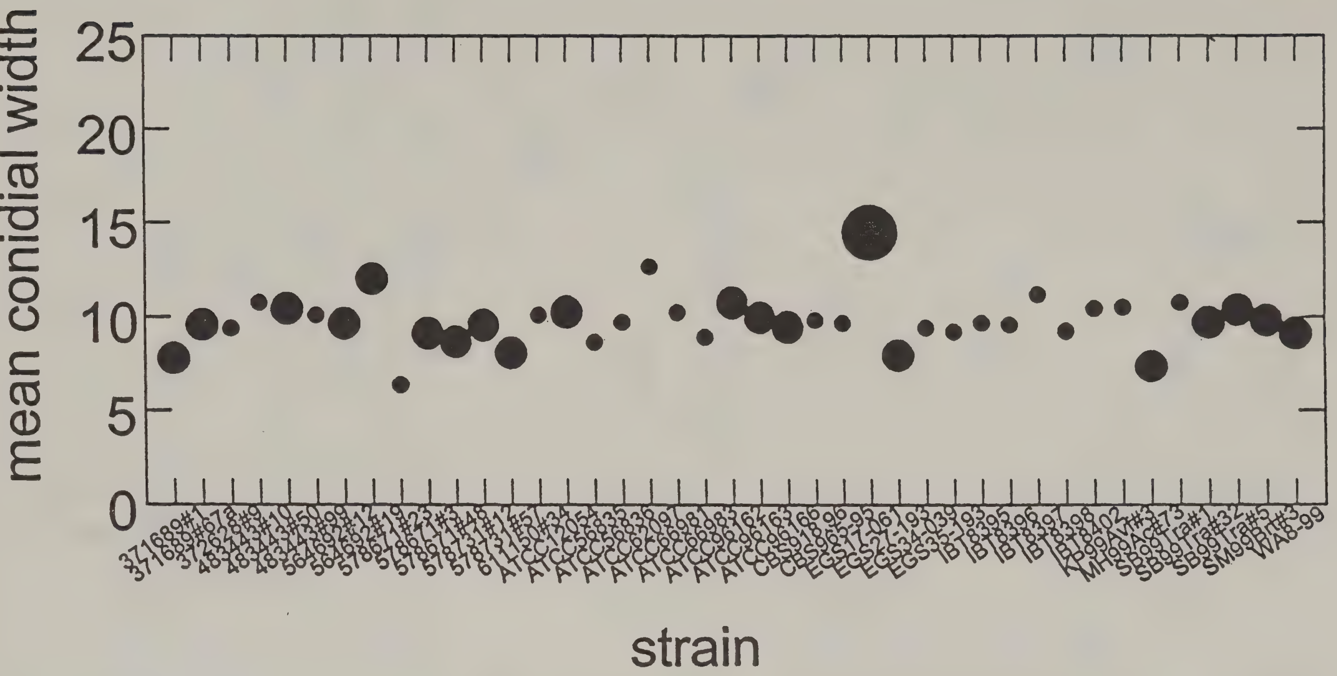


Fig. 25. Mean conidial width by strain: *A. triticina* vs. strains of other small-spored, chain-forming species. ● = *A. triticina*; ● = members of *A. infectoria* complex; • = members of *A. alternata* or *A. tenuissma* complexes. (Sample size = 75 conidia. Standard error bars ≤ diameter of smallest circle.)

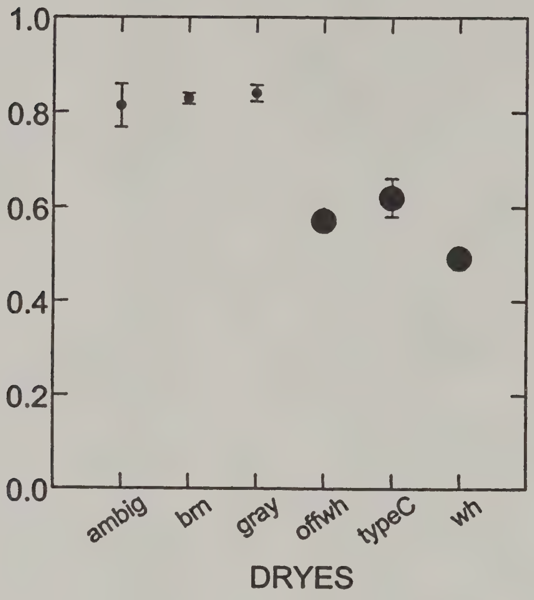


Fig. 26. Fraction of conidia with true beaks vs. DRYES reaction. DRYES reaction: ambig = ambiguous reaction of 578671#23; brn = rusty ochre brown, velutinous (14 strains); gray = gray buff, flocculent (6 strains); offwh = offwhite, flocculent (12 strains); type C = medium to pale olive, with thin, white, flocculent mycelial overlay over a velutinous base, off white in 24 hr darkness (2 strains); wh = white, flocculent (6 strains). ● = exhibiting dense sporulation clusters on PCA, *A. infectoria* complex; • = not exhibiting dense sporulation clusters (or, for 578671#23, small clusters) on PCA, *A. alternata* or *A. tenuissma* complex. Bars are standard errors; bars not seen are ≤ diam. of the circle.

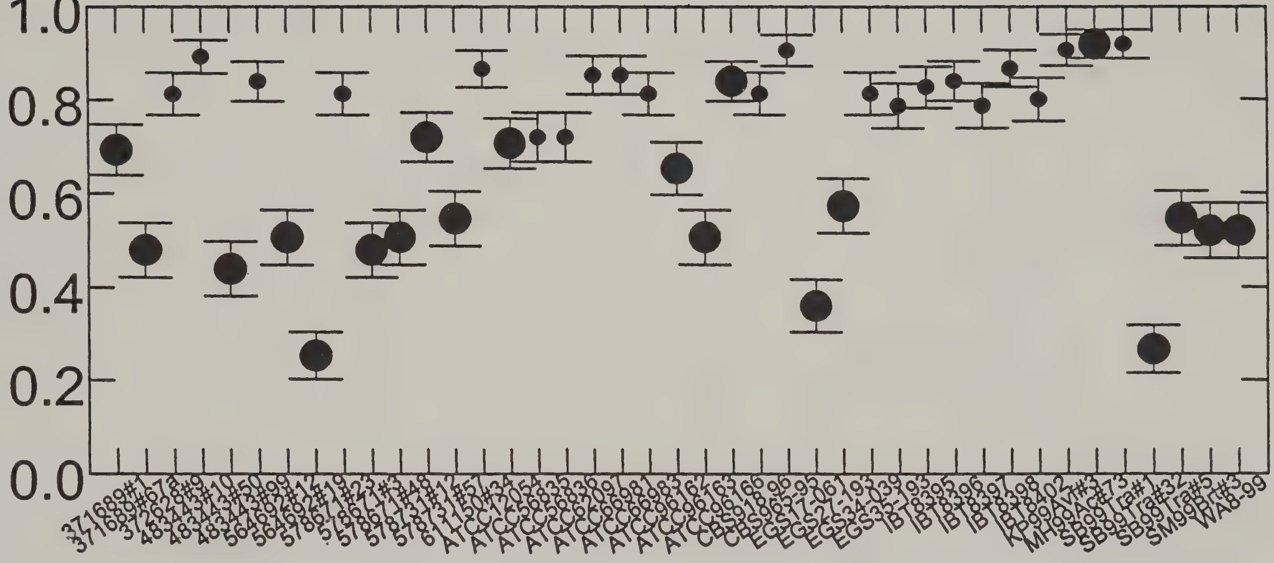


Fig. 27. Fraction of conidia with true beaks. ● = exhibiting DRYES reaction white to offwhite or type C, and sporulation clusters on PCA (*A. infectoria* complex); • = exhibiting DRYES reaction brown or gray buff and no sporulation clusters on PCA (*A. alternata* or *A. tenuissma* complex plus 578671#23). Bars are standard errors; sample size = 75 conidia/strain. Bars are standard errors.

**Table 4. Morphological characters of conidia of small-spored, chain-forming *Alternaria* species complexes.**

| Species complex | Overall means*: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | length (µm)[1] | width (µm)[2] | transepta[3] | longisepta[4] | beak[5] | length beaks (µm)[6] | false beaks[7] | length false beaks (µm)[8] |
| *A. alternata* | 21.9a | 9.4a | 2.5a | 0.4a | 0.78a | 3.3a | 0.26a | 3.7a |
| *A. infectoria* | 25.2b | 9.7b | 3.1b | 0.9b | 0.55b | 3.5ab | 0.25ab | 6.1b |
| *A. tenuissima* | 26.5c | 10.3c | 3.3c | 0.8c | 0.85c | 4.4c | 0.10c | 1.4c |

*Sample size: *A. alternata* 6, *A. infectoria* 20, *A. tenuissima* 14 strains, 75 conidia/strain. Means bearing the same letter fail to differ at $P \leq 0.05$; all others differ at $P \leq 0.01$ (LSD). [1]Mean conidial length. [2]Mean conidial width [3]Mean number of transverse septa per conidium [4]Mean number of cellular compartments containing longitudinal septa. [5]Mean fraction of conidia bearing true beaks. [6]Mean length of true beaks. [7]Mean fraction of conidia bearing false beaks. [8]Mean length of false beaks. Strains used for each species group given in Tables 1 & 3.

**Table 5. Tukey HDS Pairwise Multiple Comparisons for Means of Conidial Length, *A. infectoria* complex (selected strains):**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | | | | | | | | | |
| 2 | 0.996 | 1.000 | | | | | | | | |
| 3 | 0.109 | 0.615 | 1.000 | | | | | | | |
| 4 | 0.000 | 0.000 | 0.000 | 1.000 | | | | | | |
| 5 | 0.000 | 0.000 | 0.000 | 0.855 | 1.000 | | | | | |
| 6 | 0.000 | 0.008 | 0.782 | 0.111 | 0.000 | 1.000 | | | | |
| 7 | 0.000 | 0.001 | 0.468 | 0.312 | 0.002 | 1.000 | 1.000 | | | |
| 8 | 1.000 | 1.000 | 0.361 | 0.000 | 0.000 | 0.002 | 0.000 | 1.000 | | |
| 9 | 0.344 | 0.035 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.101 | 1.000 | |
| 10 | 0.000 | 0.000 | 0.000 | 1.000 | 0.985 | 0.026 | 0.102 | 0.000 | 0.000 | 1.000 |

| | |
|---|---|
| ATCC 96162 / SB99Tra#5* | 0.985[†] |
| SB99Tra#5 / ATCC 12054 | 1.000 |
| ATCC 12054 / ATCC 96166 | 0.102 |
| ATCC 96166 / ATCC 96163 | 0.312 |
| ATCC 96163 / 578671#48 | 0.782 |
| 578671#48 / 564692#19 | 0.615 |
| 564692#19 / EGS 27-193 | 1.000 |
| EGS 27-193 / 564692#12 | 1.000 |
| 564692#12 / MH99Ac#73 | 0.344 |

1 = 564692#12, 2 = 564692#19, 3 = 578671#48, 4 = ATCC 12054, 5 = ATCC 96162, 6 = ATCC 96163, 7 = ATCC 96166, 8 = EGS 27-193, 9 = MH99Ac#73, 10 = SB99Tra#5. 1,2,3,4, 8(ex-type), 9,10 = *A. infectoria*; 5 = *A. triticmaculans* (ex-type); 6 = *A. oregonensis* (ex-type); 7 = *A. metachromatica* (ex-type). 9 = lowest recorded mean value for length in *A. infectoria* complex, here assigned to that species. 5 = highest recorded mean value for length in *A. infectoria* complex. *Pairs of strains ordered from longest mean conidial length (ATCC 96162) to shortest (MH99Ac#73). [†]Corresponding P value for inequality between each pair.

**Table 6. Assignment of specific epithets to strains in *A. infectoria* complex, based on maximum conidial length:**

| WRPIS Number | Conidial Dimensions in µm, + outliers | Means | Keys to: |
|---|---|---|---|
| 371689#1 | (11-)15-43(-50.5) x (5-)6-10.5(-14) | mean of 24 x 8 | *A. infectoria* |
| 371689#67a | 11-64.5(-67) x (5-)6.5-14(-17) | mean of 24.5 x 9.5 | *A. oregonsis* ? (63 < 67 < 70) |
| 483443#50 | 11-49(-53) x 6-17 | mean of 26.5 x 10.5 | *A. infectoria* |
| 564692#12 | 11-36.5(-41.5) x 6-14 | mean of 21 x 9.5 | *A. infectoria* |
| 564692#19 | (10.5-)13-32(-42) x (6-)8.5-18.5 | mean of 22 x 12 | *A. infectoria* |
| 578671#3 | (10-)11.5-49.5(-57.5) x (5.5-)6.5-15.5 | mean of 23.5 x 9 | *A. infectoria* |
| 578671#48 | (8.5-)11-45(-53) x 5-13.5(-15.5) | mean of 24.5 x 8.5 | *A. infectoria* |
| 578731#12 | 9.5-43.5(-52) x 5-15.5 | mean of 23 x 9.5 | *A. infectoria* |
| 578731#57 | 10-35(-43) x 5-11((-16.5)) | mean of 18 x 7.5 | *A. infectoria* ? |
| SB99Tra#5 | (13.5-)21-52(-59) x (6.5-)8.3-13(-15.5) | mean of 31 x 10.5 | *A. infectoria* if '(-58)' for '(-59)' |
| SB99Tra#32 | 11-50.5(-51.8)((-66.5)) x 6-17 | mean of 23 x 9.5 | *A. oregonensis* ? (63<66.5<70) |
| SM99Brt#3 | 11-46(-63)((-72)) x 6.5-14.5(-17) | mean of 24 x 10 | *A oregonensis* ?? '(-63)' vs. '((-72))' |
| WA8-99 | 10-57.5 x 5-14 | mean of 22 x 9 | *A. infectoria* |
| ATCC 12054 | (10.5-)12.5-50.5(-58) x (6.5-)8-15.5(-18) | mean of 30.5 x 10.5 | *A. infectoria* (in spite of high mean) |
| ATCC 96162 | ((7-))(10-)18-56(-68.5)((-84)) x (5-)6.5-14.5(-17) | mean of 32.5 x 11 | *A. triticimaculans* (conidial max > 70) |
| ATCC 96163[*] | (11-)13.5-52(-63) x 5.5-15.5(-19.5) | mean of 27 x 10 | *A. oregonsis* |
| ATCC 96166[†] | (10-)12.5-55.5(-64)((73.5)) x (5.5-)7-14(-17) | mean of 27.5 x 9.5 | *A. metachromatica*[†] |
| EGS 27-193 ex-type | (8-)10.5-40.5(-49) x 5.5-13.5 | mean of 21.5 x 8 | *A. infectoria* |

[*] ATCC 96163: (-63) outlier not in sample of n = 75.
[†] *A. metachromatica* is keyed by color.
( ) = outlier; (( )) = extreme outlier.

**Table 7. Conidial proportions and cultural characters of strains of *Alternaria alternata*, *A. infectoria* and *A. tenuissima*.**

| **Species & strain** | **length x width*** | **true beak*** | **transepta[†]** | **longisepta[‡]** | **branching[#]** | **DRYES[¶]** |
|---|---|---|---|---|---|---|
| *A. alternata*: | | | | | | |
| ATCC 66981** | 11-39(-45) x (6.5-)8.5-12.5(-14.5) | 0-9 | 0-7 | 0-3 | SF | RBOV |
| (= EGS 34-016) | mean 23.5 x 10 | mean 3 | mean 2.6 | mean 0.5 | | |
| ATCC 66983** | (8.5-)12.5-39(-47.5) x (5.5-)7-12.5(-15.5) | 0-13 | 0-7 | 0-3 | SF | RBOV |
| (= EGS 35-056) | mean 22.5 x 9 | mean 3.5 | mean 2 | mean 0.2 | | |
| ATCC 56835 | (10-)11.5-36.5(-39) x 5.5-12 | 0-10 | 0-5 | 0-3 | SF | RBOV |
| | mean 23 x 8.5 | mean 3 | mean 2.6 | mean 0.4 | | |
| ATCC 56836 | (8.5-)10-40.5(-50.5) x (5.5-)6.5-15 | 0-12.5 | 1-6 | 0-3 | SF | RBOV |
| | mean 22 x 9.5 | mean 3 | mean 2.6 | mean 0.6 | | |
| EGS 34-039** | (7-)9-43(-49) x (5-)6-14 | 0-8.5 | 0-6 | 0-2 | SF | RBOV |
| | mean 21 x 9.5 | mean 4 | mean 2.4 | mean 0.4 | | |
| EGS 35-193** | 10-40(-42) x (5.5-)7-14 | 0-7.5 | 0-4 | 0-2 | SF | RBOV |
| | mean 19.5 x 9 | mean 3.5 | mean 2.4 | mean 0.6 | | |
| **Species & strain** | **length x width*** | **true beak*** | **transepta[†]** | **longisepta[‡]** | **branching[#]** | **DRYES[¶]** |
| *A. infectoria* | | | | | | |
| ATCC 12054[§] | (10.5-)12-50.5(-58) x (6.5-)8-15.5(-18) | 0-11 | 1-9 | 0-6 | GR | WOWF |
| (= CBS 308.53) | mean 30.5 x 10.5 | mean 4.5 | mean 4.3 | mean 1.7 | | |
| EGS 27-193 | (8-)10.5-40.5(-49) x 5.5-13.5 | 0-11 | 0-5 | 0-3 | GR | WOWF |
| | mean 21.5 x 8 | mean 3.5 | mean 2.8 | mean 0.5 | | |

**con't →**

**Table 7 continued:**

| Species & strain | length x width* | true beak* | transepta[†] | longisepta[‡] | branching[#] | DRYES[¶] |
|---|---|---|---|---|---|---|
| *A. tenuissima* | | | | | | |
| ATCC 60297[§] | (8.5-)15.5-63(-87) x (6-)10-18<br>mean 32 x 12.5 | 0-28<br>mean 6 | 0-7 M<br>mean 3.3 | 0-4<br>mean 1.4 | LI | RBOV |
| CBS 918.96**<br>(= EGS 34-015) | (7.5-)12-50.5(-55) x 6-15.5<br>mean 26 x 10 | 0-7<br>mean 3 | 0-8 M<br>mean 3.1 | 0-3<br>mean 0.6 | LI | DGBF |
| CBS 965.95 | 9.5-69.5(-75)((-88)) x 5.5-14<br>mean 28 x 9.5 | 0-44<br>mean 6 | 0-7<br>mean 3.6 | 0-3<br>mean 0.9 | LI | DGBF |
| IBT 8395 | 12.5-44(-48.5) x 5.5-13.5(-15.5)<br>mean 24 x 9.5 | 0-10<br>mean 4 | 1-6 M<br>mean 3.3 | 0-3<br>mean 0.6 | LI/SF | DGBF to RBOV at margin |
| IBT 8396 | 11-41(-52) x 6-13(-14.5)<br>mean 23.5 x 9.5 | 0-11<br>mean 4 | 1-7 M<br>mean 3.1 | 0-3<br>mean 0.6 | LI | DGBF |
| IBT 8397 | 11-50.5(-61.5)((-66)) x 6.5-15.5(-16.5)<br>mean 29.5 x 11 | 0-16<br>mean 4 | 1-8<br>mean 4 | 0-3<br>mean 1.1 | LI | DGBF |
| IBT 8398 | 12-68.5(-83.5) x 6-12.5(-14.5)<br>mean 32.5 x 9 | 0-23<br>mean 7 | 1-8 M<br>mean 3.7 | 0-3<br>mean 0.4 | LI | DGBF to WOWF |
| IBT 8402 | 14-45(-52.5) x 7-15.5<br>mean 24.5 x 10.5 | 0-11<br>mean 3.5 | 0-6 M<br>mean 3.1 | 0-3<br>mean 0.9 | LI | RBOV |

*Range (including outliers in parentheses) and mean in μm (n = 75 conidia).

**Not from grass family host, but representative strain.

[†] Range and mean (n = 75) for number of transverse septa per conidium. M denotes occasional presence of conidia with thick, median septa at which the outer walls are constricted.

[‡] Range and mean for number of cell compartments with longitudinal septa (n = 75).

[#] Branching pattern: SF = chains originating from agar surface predominantly < 10 conidia and with frequent side chains of varying length; LI = chains originating from agar surface often ≥10 conidia and with infrequent, short side chains. GR = macroscopic granular pattern arising from dense sporulation clusters. Conditions of incubation: PCA, 20C, 16 hrs darkness / 8 hrs florescent light, 7 days.

[¶] Colony on DRYES medium: RBOV = rusty brown to ochre, velutinous; WOWF = white to off white, flocculent; DGBF = dirty gray to buff , flocculent.

[§] ATCC 60297 is cataloged as *A. alternata*, but has the characters of *A. tenuissima*. ATCC 12054, see Footnote 1.

**Discussion**:

The production of keys and descriptions necessarily forces authors to examine their species concepts. For the purposes of this study, we have adopted a morphological concept. Because *Alternaria* species display only anamorphic forms *in vitro*, we cannot apply a straightforward biological species concept. (A partial exception is *Embellisia eureka* (Simmons) Simmons (= *Alternaria eureka* Simmons) of which the teleomorph *Allewia eureka* (Simmons) Simmons ( = *Lewia eureka* Simmons) has several times been produced in culture (Simmons 1986, 1990b), but this species is not graminicolous and according to Simmons (1990b) not an *Alternaria.*) We should stress that we've chosen a morphological species concept for the purposes of this study, and in different circumstances one or more operational species concepts based on molecular, physiological or phytopathological data, or a phylogenetic species concept, might be more pertinent. The application of species concepts in fungi has been reviewed (Taylor et al. 2000). For the concept of "species-groups" with regard to the names *Alternaria alternata* and *A. tenuissima*, and for the application of the species-group concept to specified isolates, see Simmons (1995b).

The greatest challenge was designating criteria for separation of the small-spored, chain-forming strains into species and species complexes. For assignment of a small-spored, chain-forming strain to *A. alternata*, *A. tenuissima* or species of the *A. infectoria* complex, it was necessary to employ a suite of characters, no one of which was individually sufficient. However, it was usually possible to assign a strain to a species on the basis of congruence amongst a majority of these characters: pattern of chain branching (following Simmons & Roberts 1993), presence or absence of dense, bushy sporulation clusters on PCA, colony morphology & color on DRYES medium, degree of development of false beaks, percentage of conidia which were beakless, length of true beak, and presence or absence of a dark, median septum about which outer walls were constricted. Assignment of name on the basis of conidial dimensions alone was impractical, indeed futile, for these small-spored, chain-formers.

The task of applying these criteria was enabled because most cultures which were ex-types or authentic cultures, or which were previously designated by Simmons as strains representative of a given species (Table 1), performed as anticipated under standard conditions. There were small (generally 1-2 µm) departures in conidium size range from published descriptions of *A. alternata* EGS 34-016 and EGS 35-056 (Simmons 1990a, 1995), and *A. tenuissima* EGS 34-015 did not produce conidia attaining the maximum length recorded by Simmons (1995). But, chain branching patterns and construction of median septa were very similar to descriptions (Simmons 1990a, 1995), enabling separation of representative strains of *A. tenuissima* from those of *A. alternata* on a morphological basis. Our experience was similar to that of Blodgett et al. (2000), who concluded that discriminating between *A. alternata* and *A. tenuissima* on the basis of the comparatively longer, unbranched chains of the latter was feasible, thereby confirming the utility of the patterns described by Simmons and Roberts (1993). The longer beaks (Tables 4 & 7) and the diagnostic median septa (Table 7), present in some but not all strains of *A. tenuissima*, were secondary useful characters. ATCC 62097, cataloged by ATCC as *A. alternata,* produced conidia with shape (often heavily tapered, and with constrictions at prominent median septa) and dimensions (length up to 87 µm) more closely matching those of *A. tenuissima* than *A. alternata*; conidial chains were long with relatively few side branches as is characteristic of *A. tenuissima* (Simmons 1995). In related, on-going research with *Alternaria* strains recovered from asymptomatic grass seeds & culm nodes and exhibiting distinctly colored (olives, browns, etc.) reactions on DRYES, approximately 90% form long, unbranched chains on V8 agar (Dugan, unpublished). We therefore suspect that morphological *A. tenuissima* sensu Simmons is far more prevalent on grasses than *A. alternata* sensu Simmons (a conclusion in accord with Andersen et al. (1996) but at variance with studies cited by Webley (1997) for cereal grains). We found no strains with sporulation patterns analogous to that of *A. arborescens* Simmons (EGS 39-128) (data not shown).

Culture collection strains of the *A. infectoria* complex produced conidia whose size ranges were not wholly in accord with descriptions and figures in Simmons (1986,1994), but sporulation patterns were as described, and length maxima for *A. infectoria* conidia were shorter than those of *A. oregonensis*, and maxima for the latter shorter than those for *A. triticimaculans*, as congruent with Simmons (1986, 1994) (Table 6). However, when combined with WRPIS strains in the *A. infectoria* complex, their mean conidial lengths failed to significantly differ in a manner that revealed clear discontinuities between species (Table 5). Many strains from the WRPIS collections displayed white, off white or type C reactions on DRYES, produced dense sporulation clusters on PCA (Table 3), and manifested microcharacters (beakless conidia, long proliferated beaks) associated with the *A. infectoria* complex (Figs. 26,27). Most strains keyed to *A. infectoria* but some keyed to *A. oregonensis* (Table 6). MH99Ac#73 produced conidia smaller than typical for any described species of the *A. infectoria* species complex (and was aberrant with regard to the fraction of conidia with true beaks, Fig. 27). Although ex-type and representative strains in the *A. infectoria* complex could be appropriately keyed on the basis of maximum conidial length, there are insufficient numbers of available strains for most species in this complex for our conclusions to be definitive. Like MH99Ac#73, *A. metachromatica* was somewhat aberrant with regard to the fraction of conidia possessing true beaks (Fig. 27), but identification of this monotypic strain is unhindered because of its distinctive color: sky blue in water and pink in lactic acid.

Strains of the *A. alternata* complex and the A. *tenuissima* complex were separable from those of the *A. infectoria* complex on the basis of colony form on DRYES and by the latter complex's production of dense, bushy sporulation clusters which produced a granular pattern on PCA (Table 3). Most strains were also separable on the basis of conidial characters (Table 4). Utilization of DRYES was more effective if strains yielding ambiguous results were incubated at 25C and in darkness (Andersen and Thrane 1996) and also at 20C under diurnal fluctuating light. One or the other protocol usually rendered an unambiguous result and usually results were congruent. We note in passing that the five IBT strains, identified by RAPDs as *A. tenuissima* group along with similar strains (Roberts et al. 2000), did not exhibit uniform DRYES reactions (Table 7). IBT 8402 differed from the others in our studies and also exhibited a divergent metabolic profile in Andersen and Thrane (1996).

ATCC 56835, cataloged by ATCC as *A. alternata,* produced a high proportion of conidia with relatively long (mean of 7.3 μm) proliferating beaks similar to those of *A. infectoria*. However, the reaction on DRYES medium was typical for a member of the *A. alternata* group. ATCC 56836 (Figs. 1, 2) was similar to ATCC 56835, and displayed a mean of 5.6 μm for length of false beaks; both produced colonies and sporulation patterns on PCA strongly resembling those produced by Simmons' representative strains of *A. alternata* (ATCC 66981, ATCC 66983, EGS 34-039 & EGS 35-193). Although ATCC 56835 and ATCC 56836 displayed longer false beaks than did representative isolates of *A. alternata* sensu Simmons there were no statistically significant discontinuities within the six strains when such lengths were analyzed with ANOVA (data not shown). EGS 34-039 was the representative *A. alternata* strain most resembling ATCC 56835 & ATCC 56836, and mean length of false beaks of EGS 34-039 and ATCC 56836 differed by less than 2 μm.

One strain (578671#23) was ambiguous with respect to both DRYES reaction and sporulation pattern on PCA, and also ambiguous with respect to conidial characters (Table 3, Fig. 26). It was therefore refractory to species complex assignment. One strain (MH99Ac#73) in the *A. infectoria* complex possessed not only the smallest conidia within the complex but had an uncharacteristically high proportion of conidia with true beaks (Fig. 27). We view these as indications that not all small-spored, chain-forming strains should be assigned names in described species and have constructed our key accordingly. We are conducting molecular-genetic studies with the aim of clarifying species assignment within the small-spored, chain-forming groups.

Strains other than small-spored taxa presented fewer challenges. Note, however, that separation of *A. saparva* from *A. longissima* is dependent on knowledge of conidiophores, aggregated into synnemata in the former. Separation on the basis of conidial characters alone is doubtful (Cejp and Deighton 1969).

Also problematic is the inclusion of *A. japonica*, a species normally associated with hosts in the cabbage family. Its occurrence here as strain KP32-00 (isolated from a surface-disinfested culm node) was not associated with symptoms and is likely only incidental. This species (as *A. raphani* J.W. Groves & A.J. Skolko) has been repeatedly recorded as isolated from grass family plants (Bruce 1984; Clear et al. 2000a, b), but is not recorded as a pathogen of those plants. Such instances may represent nothing more than spores quiescent inside sub-stomatal chambers or under cuticular waxes of non-hosts. Such rare "hitchhiking" on non-hosts may present problems for agencies regulating movements of pathogens, but need not confound the efforts of taxonomists.

Another difficulty which should be noted here is the lack of consensus regarding the etiology of Alternaria leaf blight of wheat. In spite of frequent reports of *A. triticina* as a cause of leaf blight (e.g. Anahosur 1978; Wiese 1987; Zillinsky 1983), the strain examined here (ATCC 36205 = EGS 17-061 ex-type) probably represents a rare species (Simmons 1981). Both the present study and Zillinsky (1983) characterize *A. triticina* as possessing conidia discernably larger than those of other small-spored, chain-forming *Alternaria* spp. However, it has been suggested that *A. triticina* represents an ecotype of *A. alternata* (Kumar and Rao 1976) and the dimensions of conidia as reported by Anahosur (1978) are smaller than those reported here. Our study of ex-type culture ATCC 36205, as well as previous studies (Simmons 1981), clearly demonstrate that *A. triticina* is morphologically distinct from *A. alternata*. Nonetheless, the role of *A. triticina* in leaf blight seems insufficiently defined. Persons using Ellis (1976) should note the comments of Simmons (1981) regarding the putative atypicality of material used by Ellis for illustration of *A. triticina*.

The importance of a well researched taxonomy of the genus *Alternaria* is likely to increase with time. Other than *Fusarium*, *Alternaria* is the genus with the most coverage in modern texts on seed pathology (Agarwal and Sinclair 1997; Maude 1996). *Alternaria* is a known producer of mycotoxins in cereal grasses (Chelkowski 1991; Chelkowski and Visconti 1992; Cole and Cox 1981) and may even produce toxins as an endophyte in weedy range legumes (Braun and Liddell 1998). *Alternaria* has been the genus most commonly isolated to date in investigations of quiescent infections of asymptomatic grass nodes and/or seeds conducted by the USDA-ARS WRPIS (Dugan, unpublished).

The prevalence and importance of infections of grass family plants by *Alternaria* necessitate the correct application of names to isolates from these hosts. But available taxonomic treatments of the genus *Alternaria* require improvement for the following reasons: Rotem (1994) generated a table of selected species and some of their characters, but did not provide a key nor include *A. infectoria*. Simmons produced a key to species-groups but not to species (Simmons 1992), to species on *Passiflora* (Simmons 1993), to species on Euphoriaceae (Simmons 1994a), and to the *A. cheiranthi* group (Simmons 1995b) but has not focused on *Alternaria* species on Poaceae. Ellis (1971, 1976) produced a series of descriptions from herbarium material, but no key. The keys from Joly (1964a, 1964b, 1967) are still useful, but are incomplete because of omissions of major and minor taxa. Joly (1967) was presented in translation without illustrations or descriptions; Joly (1964b) also lacks illustrations and descriptions. Joly (1964a) is illustrated, with descriptions, and with keys to sections but not to species. Neergaard (1945) is still well-regarded, but the keys omit one major and several minor species from grasses. Keys and descriptions of Joly and Neergaard are not based on standardized media or incubation conditions and are complicated by the inclusion of *Ulocladium* species within the genus *Alternaria.* (The two genera were not clearly separated until Simmons 1967.) The extensive series of articles by Simmons (*Alternaria* Themes and Variations, in Mycotaxon, 1981-present, of which the most pertinent are cited herein) is the most complete set of descriptions of *Alternaria* species in which strains have been grown under standard conditions, but the only keys are those noted above. Given the immediate needs of phytopathologists and regulatory agencies, we regard the our key and descriptions as temporary but necessary correctives.

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# CROSSOPSORA PIPERIS, A NEW RUST SPECIES FROM BRAZIL[*]

Reinhard Berndt[1)], Francisco Freire[2)] and Cléber N. Bastos[3)]

[1)] *Universität Tübingen, Botanisches Institut, Lehrstuhl für Spezielle Botanik und Mykologie, Auf der Morgenstelle 1, D-72076 Tübingen, Germany*[†]
[2)] *EMBRAPA/CNPAT, Rua Dra. Sara Mesquita, 2270, Planalto Pici, Fortaleza-Ceará, 60.511-110, Brazil*
[3)] *CEPLAC/SUPOR, C.P.1801, CEP. 66.635-110, Belém, Pará, Brazil*

*Crossopsora piperis* is described as a new species of rust fungi (Uredinales) on *Piper hostmannianum* from Brazil. It is the first member of the genus *Crossopsora* on Piperaceae. *Uredo piperinum* (= *Cerotelium piperinum*) is its uredinial anamorph.

Key words: Rust fungi, Phakopsoraceae, teliospore, germ pores

## INTRODUCTION

*Crossopsora* is a mainly tropical and relatively small genus of Phakopsoraceae with 21 recognized species, all characterized by thread-like teliospore columns. Some described species are morphologically very similar and may be synonymous. Previously, several *Crossopsora* species were assigned to other rust genera that produce similar filiform teliospore threads, especially to *Cronartium* (PETERSON 1973). The paraphysate uredinia, however, clearly distinguish *Crossopsora* from *Cronartium* that has uredinial peridia of the pucciniastraceous type (COLLEY 1918, MOSS 1926) The host spectrum of *Crossopsora* is broad and comprises species from 13 families of eu-dicots.

In the present paper we describe a new species of *Crossopsora* from Brazil on a host family new for the genus.

## MATERIALS AND METHODS

Herbarium material was used for examination: spores and hand sections were mounted in lactophenol and gently heated to boiling. The figures for spore measurements comprise the extremes (in brackets), the usual range of measures and the arithmetic means (bold typeface). Teliospore measurements were taken from the middle parts of teliospore threads.

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[†] Corresponding author. E-mail: reinhard.berndt@uni-tuebingen.de

## TAXONOMY

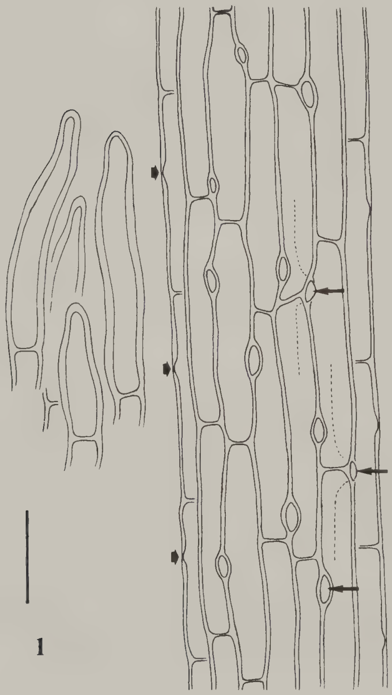
***Crossopsora piperis*** R. Berndt, F. Freire & C.N. Bastos, sp. nov. (Figs. 1, 2)
Anamorph: *Uredo piperinum* (Syd.) R. Berndt (= *Cerotelium piperinum* Syd.)

**Uredinia** foliicola, praecipue adaxialia, gregaria et saepe nonnihil circinnata in maculis fuscis foliorum, ca. 2-3 mm diam., obscure ad nigro-brunnea, immersa, concava, leviter bullata, ca. 0,2 –0,3 mm diam., primo epidermide hospiti tecta, tarde exposita fissura epidermidis, paraphysata, paraphysibus ± cylindricis, introrsum incurvatis ad aperturam uredinii, saepe indistinctis et inter se crebre adhaerentibus et tum peridio similibus, crasse tunicatis (2-3 µm) cum pariete ochraceo ad dilute brunneo. **Urediniosporae** breviter pedicellatae, ellipsoideae vel obovoideae, 29-**33,8**-38 (44) x 19-**21,6**-25 µm, pariete ubique 1-1,5 µm crasso, ochraceo ad dilutissime brunneo, aequaliter et aliquantum dense echinulato spinis delicatis, poris germinationis obscuris.
**Telia** foliicola, abaxialia, sparsa, urediniis opposita, minuta (ca. 100–200 µm diam.), subepidermalia, immersa, concava, cum basi bullata et fuliginosa, paraphysata, paraphysibus ± cylindricis praedita, rectis vel leniter incurvatis, gradatim contractis ad apicem obtusum vel subacutum, crasse tunicatis pariete dilute brunneo ad castaneo. **Teliosporae** catenulatae, fila delicata, porphyrea, ca. 45-65 µm lata et 2-4 (5) mm longa efferentia, anguste fusiformes vel rectangulares, 33-**56,5**-78 x 8-**9,7**-13 µm, pariete levi, ca. 1 µm crasso, aurantio-brunneo, poris germinationis singulis, inconspicuis in medio sporarum vel tertia parte superiore praeditae, teliosporae centrales processibus praeditae sunt qui attingunt superficiem filorum teliosporarum et poros germinationis ferunt.
In foliis *Piperis hostmanniani* (Miq.) C.D.C. (Piperaceae).

**Uredinia** on leaves, mostly adaxial, crowded on irregular round brown spots of ca. 2-3 mm diam., often roughly circinnate, dark to blackish brown, deep-seated, concave, slightly bullate, ca. 0.2-0.3 mm diam., covered by the host epidermis, becoming exposed tardily by rupture of the epidermis, uredinia paraphysate, paraphyses ± cylindrical, bent towards the opening of the uredinium, often indistinct, tightly adherent to each other and overarching the sorus like a peridium, thick-walled (2-3 µm) with an ochraceous to light brown wall. **Urediniospores** shortly pedicellate, ellipsoid to obovoid, 29-**33.8**-38 (44) x 19-**21.6**-25 µm, spore wall evenly 1-1.5 µm thick, ochraceous to light brown, rather closely and delicately echinulate by slender spines, germ pores obscure.
**Telia** on leaves, abaxial, scattered opposite to uredinia on the same discoloured leaf spots, tiny (ca. 100–200 µm diam.), originating subepidermally, deep-seated, concave, bullate, blackish brown at the base, paraphysate, paraphyses ± cylindrical, tapering towards their blunt or subacute tip, straight or slightly bent inwards, thick-walled, with light to chestnut brown wall. **Teliospores** arranged in slender, thread-like, dark reddish brown columns that emanate from the bullate base, threads ca. 45-65 µm in diam., 2-4 (5) mm long (often breaking shorter), composed of narrowly fusiform or approx. rectangular teliospores, 33-**56.5**-78 x 8-**9.7**-13 µm, mostly 45-65 x 9-11 µm, spore wall ca. 1 µm thick, smooth, orange brown, with an inconspicuous germ pore in the middle or upper half of the spores, germ pores of central spores of the threads located at the tip of beak-like projections that reach the surface of the threads between the peripheral teliospores.
On the leaves of *Piper hostmannianum* (Miq.) C. D. C. (Piperaceae).

Holotype (UB): Brazil, state of Pará, Marituba county, road Belém - Marituba, at km 17, Ceplac Experimental Cocoa Station "José Haroldo", 1°12'00''S 48°13'30''W, 10 May 2001, on *Piper hostmannianum* (Miq.) C.D.C. (Piperaceae), leg. Cléber N. Bastos (isotypes in B and herbarium R. Berndt, *HeRB 6466*).

The present rust was assigned to *Crossopsora* because of the teliospores that are arranged in slender threads and the presence of peripheral paraphyses in both uredinia and telia (Figs. 1, 2). The species is different from other members of the genus *Crossopsora* by the combination of morphological characters and its presence on a member of Piperaceae, a new host family of the genus.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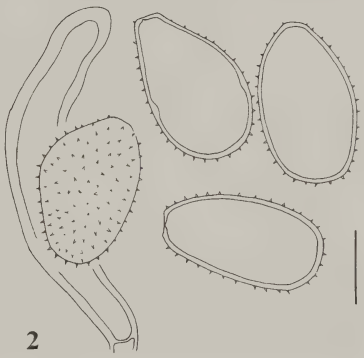
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**Fig. 1**. Part of teliospore thread (from middle part) composed of narrowly rectangular or fusiform teliospores. Long arrows indicate germ pores of central spores of the thread located on beaked processes. Germ pores of peripheral spores (short arrows) are shallow and inconspicuous. Some telial paraphyses are delineated to the left. Scale bar = 25 µm.
**Fig. 2**. Urediniospores and a uredinial paraphysis. Scale bar = 15 µm

A salient feature of the teliospore threads of *C. piperis* are bordered ovals or slots between the peripheral teliospores (Fig. 1, long arrows). These structures are formed by beak-like processes produced by the internal teliospores of the telial threads that wedge through adjacent peripheral teliospores. Similar but less obvious beaked internal teliospores could also be observed in *C. byrsonimatis* (P. Henn.) R.S. Peterson (on *Byrsonima*, Malpighiaceae). In the present species, the germ pores of the peripheral spores are difficult to see as the spore wall is thin and germ pores remain inconspicuous. In other species of the genus *Crossopsora*, e.g. *C. byrsonimatis*, the germ pores are much more conspicuous, probably due to a strongly thickened outer cell wall of the teliospores.

Telia and uredinia of the present species are provided with peripheral paraphyses. The paraphyses originate from a cellular base that surrounds the hymenial part of the sori like a wall. According to the uredinium typology of ONO et al. (1992), such uredinia are placed in "*Malupa*", a morphotype widespread in several genera of Phakopsoraceae. Paraphyses were difficult to discern in many uredinia, as they tend to form a tight and coherent peridium-like layer that arches over the sori.

The uredinial stage of *Crossopsora piperis* is very similar to *Cerotelium piperinum* Syd. (based on II), recently recombined to *Uredo piperinum* (Syd.) R. Berndt (BERNDT 2002). We consider *Cerotelium piperinum* and *Uredo piperinum* to be the same as *Crossopsora piperis* and therefore treat them as synonyms of the latter species. *Crossopsora piperis* has a wide distribution in the Neotropics, as indicated by reports from Brazil, Ecuador, Venezuela and Costa Rica.

## ACKNOWLEDGEMENTS

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# ASPERGILLUS PERSII: A NEW SPECIES IN CIRCUMDATI SECTION

Mirca ZOTTI and Aurora MONTEMARTINI CORTE

Dipartimento per lo Studio del Territorio e delle sue Risorse (DIP.TE.RIS.)
Università degli Studi di Genova - Corso Dogali 1/M Genova, Italy
E-mail: Mirca.Zotti@klaatu.com.dist.unige.it, amontem@unige.it

**Key Words***:* *Aspergillus*, opportunistic fungi, onychomycosis.

## Abstract

The paper deals with a new species of *Aspergillus* section Circumdati, an important group within the genera *Petromyces* (Malloch & Cain, 1972) and *Neopetromyces* (Frisvad & Samson, 2000) and within the anamorph genus *Aspergillus*. This species was isolated from a woman affected by onychomycosis. Some of the characters observed, such as the sclerotia and club-like enlargements, are quite peculiar and suggested that a new species *A. persii*, should be proposed.

Furthermore, colonies were cultivated on five different media and kept at different temperatures. Their morphological characters were analyzed and compared with those of the Terrei and Flavipedes sections.

## Introduction

The incidence of opportunistic fungal infections, as in the case of onychomycosis, has increased drastically due, for instance, to resistance to antifungal agents. It has enabled the existence of new species of fungi never observed before to be highlighted. The isolation of a new species and the study of its morphological characteristics are very interesting issue, not only from a taxonomic point of view, but especially for determining its sensitivity towards some antifungals.

This paper discusses a species of *Aspergillus* isolated by Agostino Persi in January 1999 from a patient who was affected by onychomycosis of the great toe nail.

The original culture was grown on modified Sabouraud medium (see below). The general morphological characters matched those of genus *Aspergillus* (Raper and Fennell, 1977; Christensen, 1982; Klich and Pitt, 1988). The fungus was cultivated on different media and at different temperatures. For each medium employed, morphological elements and their sizes were noted.

Our observations carried out on this strain suggest that it belongs in section Circumdati (Gams et al. 1985) and is probably a new species. The assignment of a new species to a section Circumdati could be temporary, since this section is under revision, based both on biomolecular techniques (Varga et al. 2000a, Varga et al. 2000b) and on profiles of secondary metabolites. Using the latter kind of analysis, J.C. Frisvad (personal communication) confirmed that our strain is a new species, close to *A. sclerotiorum* Huber and to *A. melleus* Yukawa (=*A. quercinus* (Bainier) Thom & Church, Raper and Fennell, 1977).

## Material and methods

The fungus was isolated at the Section of Tropical Dermatology-University of Genoa and repeatedly obtained in pure culture (five times through three years).

Development at three temperatures (18-25-37 °C) was studied on the following media (Samson and Pitt, 1985): Czapek Agar (Cz), Czapek Yeast Extract Agar (CYA), Czapek Yeast Extract Agar with 20 % sucrose (CY20S), Malt Extract Agar (MEA); modified Sabouraud (Sab): 15% agar, 10% glucose, 5% neopepton. The most significant morphological elements were measured. The sizes are reported using three numbers corresponding, respectively, to the minimum, the average and the maximum values of a set of measurements. The color notations reported in brackets were taken from Kornerup and Wanscher (1978).

## Description

### Cz

Colonies 28-30-32 mm in diameter after growth for 10 days at 24-26 °C, in natural light, were medium-sized, plane, floccose with low subsuperficial margins and sparse white mycelium. They sporulated heavily and were characterized by a pale yellow to light yellow (4 A3-4) color. A light amber to yellow exudate was sometimes present. The reverse side of the colony was brownish orange (5 C4-6). Odor not distinctive.

**Conidial heads** 49-61.5-71 μm in diameter, radiate, but sometimes loosely columnar, reddish yellow (4 B6-7).

**Conidiophores** 232-388.8-637x4.4-5.5-6.9 µm, longer near the edges of the colony, slightly thick-walled, sometimes with pigmented protoplasm, echinulate, occasionally with fairly well developed bubble-like concretions.

**Club-like enlargements** 3-5-6x5-7.2-8 µm of the mycelium (3-3.6-4.5 µm in diameter) were observed after ten days. These enlargements resemble the "en raquette" mycelium of *Microsporum* as described by Sabouraud (1910).

**Vesicle** 10-15-17 µm in diameter, subglobose.

**Metulae** 5.5-5.7-7x3-3.2-3.8 µm consistently present, crowded and covering at least the upper third of the vesicle, non-septate, cylindrical to truncated conical with phialides on the larger face.

**Phialides** often 3-5 per metula, 6.3-6.7-7x 2-3-3.2 µm.

**Conidia** smooth to delicately roughened, globose, diameter 2.7-2.8-3 µm.

**Sclerotia** globose, 450-540-600 µm in diameter, few or scattered, pastel to pale yellow (3 A3-4, 4 A3) thick-walled in a weft of hyphae, internal composed by sclerenchyma like thick-walled cells. Sclerotia well developed after 10 days at 37°C and 15 days at room temperature.

No evidence of asci throughout a 10 weeks period.

### CYA

Colonies 28-30-33 mm in diameter after 10 days at 24-26°C, deep, with few shallow radial furrows, subsuperficial irregular edges and floccose white mycelium. Sporulating abundantly from the basal mycelium and from aerial hyphae, pastel yellow to light yellow (3 A3-4, 4 A3-4). Exudate absent. Color of the reverse side of the colony brownish yellow to light or golden brown (5 B7, 5 C7). Odor not distinctive.

**Conidial heads** loosely columnar, sometimes radiate, pale yellow, approximately 44-48.3-49 µm, light to grayish/reddish yellow (4 A4, 4 B6-7).

**Conidiophores** 379-520-673x6.3-6.7-7.3 µm, in general slightly thick-walled, occasionally with light to golden brown (5 B6-7) pigmented protoplasm and with bubble-like concretions.

**Club-like enlargements** 4.9-6-6.5x7.3-9.6-11 µm, were observed on mycelium measuring 4.4-4.7-5.6 µm.

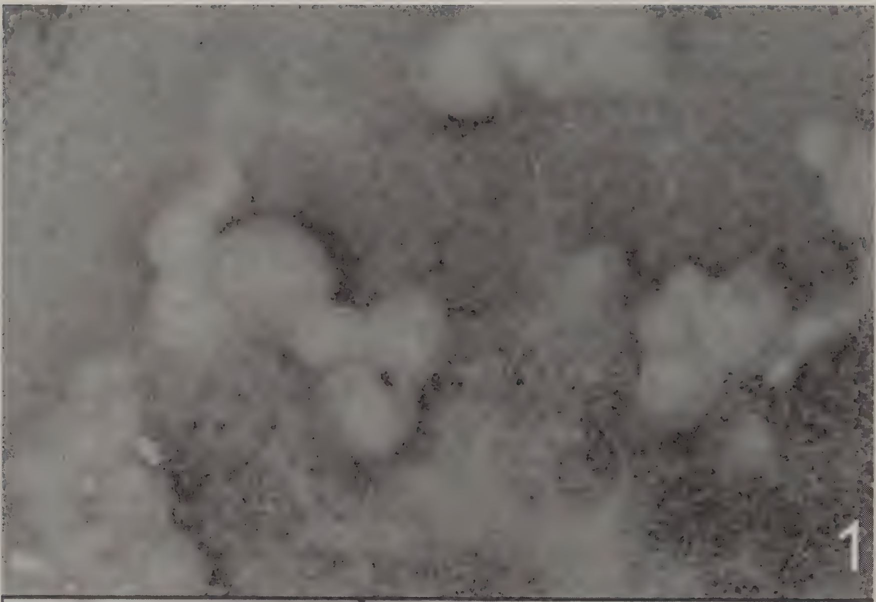
**Vesicle** 17-20.3-23.3 µm in diameter, subglobose .

**Metulae** 5.5-7.5-9x3.5-4.3-6 µm, non-septate, cylindrical to truncated conical in shape with phialides on the larger face.

**Phialides** 2-5 per metula, 5-5.4-7.5x2-2.1-3 µm.

**Conidia** globose, smooth, 2.5-3.3 µm in diameter, mostly near 2.7.

**Sclerotia** numerous after three weeks (Fig.1) at 37 °C, either scattered or slightly aggregated, with sizes ranging from 400 to 730 µm, cottony, with thick-walled cells similar to hülle cells (Fig.2). No evidence of asci throughout a 4-month period.



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After ten days the appearance of the colonies on CYA kept at a constant temperature of 37°C was similar to colonies kept at 24-26°C, with zones characterized by white to yellowish-white mycelium (4 A2) and sparse conidial heads. Four weeks later, at room temperature, the cultures had abundant sclerotia. These were round and clustered into groups of 4-5. Their appearance was globose or subglobose (440-770 µm), relatively hard and the color was pale greyish yellow or greyish orange (4 B3-4, 5 B3-4).

After 10 days, on CY20S at 25°C, the cultures had the same features as those grown on CYA, although most of the morphological elements seemed to be more developed. Furthermore, it was possible to observe conspicuous conidiophores and a more abundant sporulation (Fig.4).

Cultures on Sab at 37°C were also examined: their development was similar to those on CYA with the exception that variance in conidial size was greater (1.5-3.1-4.9 µm).

## MEA

Colonies 2.5-3-3.5 mm in diameter, after 10 days at 24-26°C, low, plane, floccose, with heavy sporulation and low, subsuperficial, transparent edges. The colonies and their reverse side were light yellow to pale yellow (4 A3-4) and grayish yellow to reddish yellow (4 B5-7) in color, respectively.

**Conidial heads** 50-56.3-66µm loosely columnar to loosely radiate (Fig.6).

**Conidiophores** 294-394-514x3.2-4.8-6.1 µm, slightly thick-walled (1µm), sometimes with small bubble-like concretions (Fig.6).

**Club-like enlargements** 6.1-7.7-9.4x8.6-9.4-11 µm were observed on the mycelium measuring 4.9-5.7-7.3 µm (Fig.6).

**Vesicle** 12-16-25 µm in diameter, subglobose to globose.

**Metulae** 6-7.2-8.5x 3-3.8-4.5 µm.

**Phialides** 6-6.5-7.5x2-2.1-2.5 µm, 3-5 per metulae (Fig.6).

**Conidia** globose, 2.3-2.7-3.4 µm in diameter.

**Sclerotia** abundant after three weeks but scattered, cottony, slightly less hard than those observed on other media, 400 to 850 µm in diameter (Fig.3). It should be noted that there were sometimes small cottony tufts that could be considered a sort of sclerotia that had not yet developed. Growth of the colony on MEA was observed for eleven days for cultures kept at three different temperatures, specifically 35, 25, and 18 °C. Fig. 7 reports the

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Fig. 1 Sclerotia in CYA after ten days at 37°C and then kept at room temperature for four weeks. (x25).

Fig. 2 Thick-walled cells from sclerotia on CYA.(x500).

Fig. 3 Not fully developed sclerotia on MEA (kept at room temperature) and loosely columnar and radiate conidial heads.(x20).

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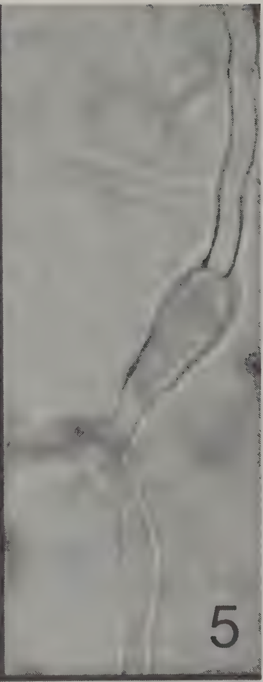
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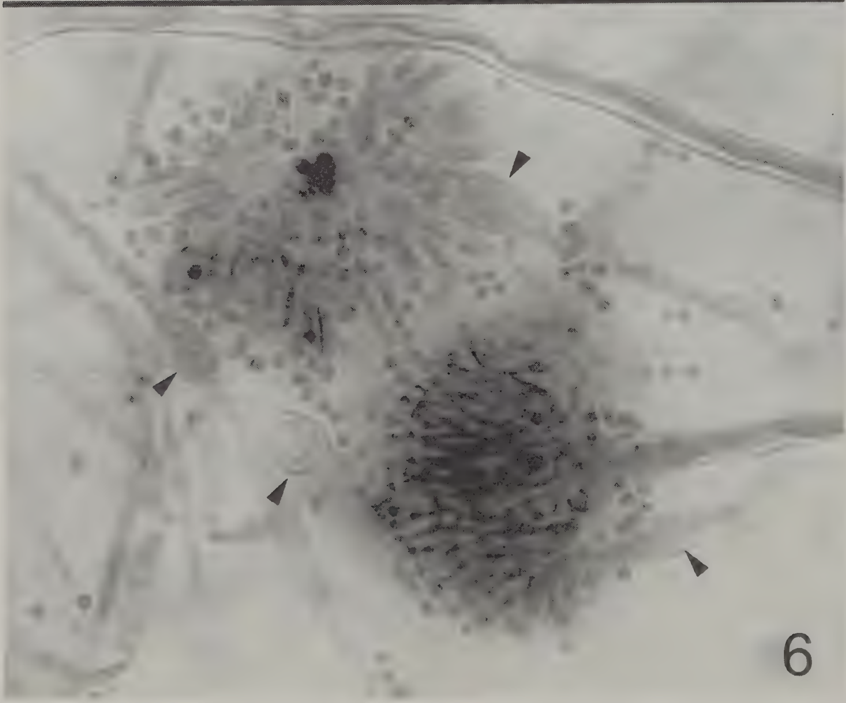
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growth behavior as a function of time at the three previously mentioned temperatures.

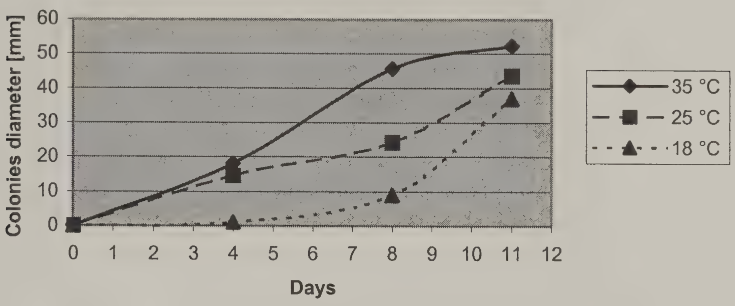

Fig.7 Growth of the colonies plotted against time for three different temperatures.

## Secondary metabolites

The secondary metabolites produced by *A. persii* are penicillic acid, xanthomegnin, viomellein, vioxanthin and cyclopenol. Chiefly cyclopenol and some other unknown secondary metabolites make this new species different from other species in Circumdati section (Frisvad, personal communication).

## Discussion

Based on a first observation of the colony, the colours of this *Aspergillus* are typical not only of the Circumdati section, but also characteristic of the Terrei section (Gams et al. 1985), specifically of the species *A. terreus* var. *aureus* Thom and Raper, and *A. terreus* var. *africanus* Fennell and Raper (Raper and Fennell, 1977). As concerns *A. terreus* var. *africanus,* the latter has no proper sclerotia, only sclerotium-like (pseudosclerotia) bodies, while *A. terreus* var. *aureus* has no sclerotia at all. The presence of sclerotia as well as the colour of the culture indicated that this species belongs to the section Circumdati (Raper and Fennell, 1977; Christensen, 1982; Gams et al., 1985). It should be remarked that the abundance of sclerotia varied depending on the medium employed, on the temperature and culture time.

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Fig. 4 Conidial heads, club-like enlargements and conidiophores with bubble-like concretions (arrow) CY20S. (x1000).
Fig. 5 Club-like enlargements near a foot-cell on Sab. (x1000).
Fig. 6 Conidial heads, club-like enlargement (arrow) and phialides, 2-5 per metula, on MEA. (x1000).

In particular, the *Aspergillus* species under study is similar to *A. melleus, A. sclerotiorum* and *A. sulphureus* var. *crassus* Rai, Agarwal & Tewari.

As far as *A. melleus* is concerned, the colonies and sclerotia are similarly sized, and the surface colour of the colonies is also similar. *A. persii* resembles *A. sclerotiorum* as regards the sometimes concentric arrangement of the sclerotia. Our *Aspergillus* has thick-walled cells similar to those of *A. sulphureus* var. *crassus*, which however has larger colonies. Unlike these three species, our fungus has smaller conidiophores, conidial heads and vesicles, the elements are similar in size to those of *A. flavipes* section Flavipedes, the anamorph of *Fenellia flavipes* (Wiley and Simmons, 1973).

Nevertheless, the presence of sclerotia and typical color of colony (yellow shade) further confirm placement in section Circumdati. Besides the revised section Circumdati of Varga et al. (2000a) includes *A. melleus, A. sclerotiorum* and *A. sulphureus.*

Moreover, the club-like enlargements on the large hyphae is another distinctive feature. They can be regarded as sort of not fully developed conidiophores, since one was observed near a foot cell (Fig.5). The presence of these enlargements on all media suggested that they are typical of the species and not simply a morphological alteration of an opportunistic fungus.

Other species in *Aspergillus* have been recorded in onychomycosis (Gupta and Elewski, 1996; Midgely and Moore, 1996; Tosti et al., 2000;) thus confirming the opportunistic nature of this genus.

The species of *Aspergillus* causing onychomycosis are seldom identified. Often, the fungi are simply referred to as "*Aspergillus* spp.". In the literature, the *Aspergillus* species usually involved in onychomycosis and that have been identified are: *A. terreus* (Onsberg et al., 1978;), *A. niger* (Tosti and Piraccini, 1998; Ng et al., 1999;), *A. versicolor* (Torres-Rodriguez et al.1998) and *Emericella nidulans* (Ng et al., 1999 as the anamorph *A. nidulans*); none of them in Circumdati section.

Briefly, small size of conidial heads, vesicles and club-like enlargements are unique aspects, together with a red brown or orange brown colony reverse on Cz, CYA and MEA. These features and the secondary metabolite analysis, carried out by J.C. Frisvad, indicate that isolate represents a new species in the Circumdati section, with the following Latin diagnosis:

***A.persii*** A. Montemartini Corte et M. Zotti

***Coloniae*** *in agaro Czapekii* 28-32 mm *diam. post dies* 10 *sub calore* 24-26 °C *crescentes; bene fructum ferentes, sufflavae vel luteolae* (4 A3-4), *facies coloniarum flocculosa vel leviter funicolosa; exudatum exiguum luteolum vel sucinum; pars postica aurea-fuscula* (5 C4-6); *nihil olentes.*

***Capitula conidica*** 49-71 *μm diam., radiantia, sed aliquoties subcolumnaria, cinerea-luteola vel crocea* (4 B6-7), *biseriata;* ***conidiophori*** *plerumque* 230-640 x 4.4-6.9 μm, *sed paulo longiores in limite coloniarum,*

*membranis crassis et perlucidis interdum carunculis pustulosis increscentibus praeditis et protoplasma aliquoties pigmento praedito.*

*Nonnulli* ***tumores*** *manifesti in micelio* 3-4.5 µm, *claviformes, qui admonent micelium "en raquette"* Microsporii *(Sabouraud, 1910).*

***Vesiculae*** *subglobosae* 10-17 µm *diam.*

***Metulae*** *non septatae, cylindratae ad leviter dilatatae in culmine* 5.5-7 x 3-3.8 µm.

***Phialides*** *plerumque* 3-5 *in una quaque metula insidentes:* 6.3 -7 x 2-3.2 µm.

***Conidia*** *laevia vel leviter granosa, globosa* 2.7 - 3 µm.

***Sclerotia*** *disseminata vel leviter congregata,* 450- 600 µm *luteola* (3 A3,4, 4A 3) *orientes ab hyphis coactis in capsulis sub conclavis temperie, pariete crassa lutea-fuscula et in intima parte repleta coacervatis "hulle" cellulis. Sclerotia frequentiora sunt in capsulis servatis aliquamdiu sub calore 37°C.*

*Hic Aspergillus suis sclerotiis et colore (flavo) pertinet ad sectionem Circumdati. Proximus est* A. melleo, A. sclerotiorum *et* A. sulphureo *var.* crasso *a quibus differt quod habet capitula conidica, conidiophoros et vesiculas minutiores.* A. sulphureus *var.* crassus *dissimilis est etiam mensurae maioris coloniae.*

*Tumores claviformia sunt alia proprietas* A. persii.

*Cultura tipica:* MUCL[3] 41970, *ianuario* 1999 *isolata ex ungue pedis matronae a claro viro* Agostino Persi.

**Acknowledgements**

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# TWO CYPERICOLOUS SMUT FUNGI (USTILAGINOMYCETES) FROM THE THIAN SHAN AND THEIR BIOGEOGRAPHIC IMPLICATIONS

ANDRZEJ CHLEBICKI

*Polish Academy of Sciences, W. Szafer Institute of Botany, Lubicz 46, PL-31-512*
*Kraków, Poland, e-mail*: chlebick@ib-pan.krakow.pl

**Abstract**: Two smuts, *Anthracoidea elynae* and *A. stenocarpa* sp. nov. were found in northern Thian Shan (Kazakhstan). *Anthracoidea stenocarpa* is more comparable to *A. sempervirentis* than it is to *A. misandrae* or *A. altera*. All of these species parasitize various species of *Carex* (section *Aulocystis*). Occurrence of highly specialized *A. stenocarpa* on *Carex stenocarpa* confirms the opinion that the host is a distinct species. A similar species, *Anthracoidea nepalensis*, previously recorded on *Carex haematostoma*, appears to be a member of a different *Anthracoidea-Carex* complex.

**Key words**: *Anthracoidea stenocarpa*, *A. sempervirentis*, *A. elynae*, *A. nepalensis*, *Carex*, *Kobresia*, Kazakhstan, Dzhungar Alatau Mts., biogeography

## INTRODUCTION

The Thian Shan mountains, situated in Kazakhstan and China between the high Central Asiatic mountains and the tremendous chains of the Siberian mountains, can be considered as a southern limit for arcto-alpine plants and fungi that dispersed during the glacial period. The plants include typical arcto-alpine plants such as *Carex microglochin*, *C. atrofusca*, *Lloydia serotina*, *Primula nivalis* and others. Simultaneously the same mountains enabled migration in the opposite direction. Central-Asiatic elements, such as *Thylacospermum caespitosum* and others, reached the northern Thian Shan from the South.

This investigation was limited to *Carex stenocarpa*, a W-Central-Asiatic element, and to *Kobresia myosuroides* which is circumpolar in its distribution.

Smut fungi belonging to the genus *Anthracoidea* parasitize both selected species. Highly specialized, homothallic fungi (Kukkonen & Raudaskoski 1964), can be considered as important biogeographic markers, which enable verification of the phytogeographic status of the host. Parasites often follow the evolution of the hosts. Such intimate relationships between cyperaceous plants and parasitic fungi have been reported by Savile (1952, 1990), Kukkonen (1963), Nannfeldt (1979), Vánky (1979) and Salo and Sen (1993). The smut fungi are abundantly distributed and highly informative (Savile 1990).

KOBRESIA MYOSUROIDES (Vill.) Fiori & Paol. (Section *Elyna*)
Syn.: *Kobresia bellardii* (All.) Degl.

Four species of the genus *Kobresia* occur in the Dzhungar Alatau Mts. Of these *K. myosuroides* is arcto-alpine in its distribution. It is a circumpolar species (Hultén 1962) known from many arctic and alpine regions of the Holarctic e.g., Europe, Ural Mts., Central Asia (Dzhungar Alatau Mts.), Mongolia, Taimyr Peninsula, Putorana Mts., NE Siberia, Korea, N America, Greenland, Iceland and Spitsbergen. The plant population in the Dzhungar Alatau Mts. forms tussocks with culms averaging 20-28 cm. The investigated plants were growing in mesic meadows on a stream terrace above 3000 m elevation in the Little Baskan Valley. Almost every plant was infected by smut.
According to Kukkonen (1961) three species of *Anthracoidea* have been reported on the host genus *Kobresia*:

*Anthracoidea kobresiae* (Mundk.) Kukkonen has been reported on *Kobresia laxa* Nees, syn. *Schoenoxiphium laxum* (Nees) N. A. Ivanova (section *Kobresia*), a Central-Asiatic species, in Kashmir and Pakistan (Kukkonen 1961, 1963, Ahmad 1956). According to Dickoré (1995) it is closely related to *K. royleana* (Nees) Boeck.

*Anthracoidea elynae* (Syd.) Kukkonen has been noted on *Kobresia myosuroides* and *K. sibirica* Turcz. (section *Elyna*). It is a circumpolar species found in Europe, Asia and N. America (Schwarzman 1960, Kukkonen 1961, 1963, Nannfeldt 1979, Vánky 1995). The smut has been reported from localities nearest to Kazakhstan on *Kobresia myosuroides* in the Saur Mts. and *K. capillifolia* C. B. Clarke in the Zailijskij Alatau Mts., the Kungej Alatau Mts. and the Tarbagataj Mts. by Schwarzman (1960). Karatygin and Simonjan (1985) noted it on *Kobresia schoenoides* (C. A. Meyer) Steudel and *K. macrolepis* Meinsh. (section *Elyna*) in Caucasus.

*Anthracoidea lindebergiae* (Kukkonen) Kukkonen, has been noted on *Kobresia simpliciuscula* (Wahlenb.) Mack. and *K. royleana* (Nees) Boeck., possibly *K. humilis* (C. A. Meyer) Serg., circumboreal-montane species found in N and Central Europe, Asia (Himalayas) and N America (Kukkonen 1963, Vánky 1995).

CAREX STENOCARPA Turcz. ex V. I. Krecz.
Syn.: *Carex tristis* M. Bieb. subsp. *stenocarpa* (Turcz. ex V. I. Krecz.) T. V. Egorova, *Carex sempervirens* Vill. var. *asiatica* B. Fedtsch.; *Carex tristis* M. Bieb. var. *asiatica* Litv.; *Carex leariterminalis* T. Koyama.

To date, thirty eight species of the genus *Carex* have been reported from the Dzhungar Alatau mountains (Poljakov 1958). According to Poljakov (1958), Malyshev et al. (1990), Dickoré (1995), Kukkonen (1998) and Egorova (1999) *C. stenocarpa* occurs in the Altai Mts., Mongolia, W & E Siberia, Turkestan, Dzhungaria, Tian Shan, Pamir-Alai, Kashgaria, W Kunlun, NE Afghanistan (Wakhan), Karakorum and in the W. Himalayas. The plant population in the Dzhungar Alatau Mts. is locally profuse on windblown ridges, and sparse in alpine desert and rocky moraines. During this investigation, only a single plant was found infected by smut.

## RESULTS

**Anthracoidea elynae** (Syd.) Kukkonen, Ann. Bot. Soc. Zool-Bot. Fenn. "Vanamo" 34: 65. 1963.

Sori in the ovaries, spores subcircular, disc-shaped, 17-19 x 15-18 µm in diameter in face view, in side view 9-10 µm thick, dark reddish-brown to blackish brown, surface smooth, with indistinct internal swelling, in SEM the concave centre is irregularly verrucose with partly confluent warts, margins very finely verrucose (Fig. 1A, B).

HOST: *Kobresia myosuroides* (Vill.) Fiori & Paol.

SPECIMENS EXAMINED: **Kazakhstan**: N Thian Shan, Dzhungar Alatau Mts., on *Kobresia myosuroides* growing in mesic meadows on stream terrace in Little Baskan Valley, N 45°09'46" E 80°11'52", ca 3000 m elevation, 15 August 2001, coll.: A. Chlebicki, KRAM 43554, HUV 19774.

Of the four *Anthracoidea* species (Table I) on the members of the *Carex* section *Aulocystis* Dumort. (sect. *Frigidae* Fries ex Kük.), the collection from the Dzhungar Alatau Mts. is very close to *A. sempervirentis*.

Table I. Some *Anthracoidea* species, their hosts and host section according to Chater (1980) and Egorova (1999)

| fungus name | host species | host section | fungus distribution |
|---|---|---|---|
| ***A. altera*** | *Carex fuliginosa* subsp. *misandra* | *Aulocystis* | sub-arctic |
| ***A. misandrae*** | *Carex fuliginosa* subsp *fuliginosa, C. fuliginosa* subsp. *misandra C. atrofusca, C. ferruginea, C. firma* | *Aulocystis* | arcto-alpine |
| ***A. sempervirentis*** | *Carex sempervirens, C. brachystachys, C. ferruginea, C. fimbriata, C. firma, C. kitaibeliana, C. macrolepis, C. mucronata* | *Aulocystis* | alpine |
| ***A. stenocarpa*** | *Carex stenocarpa* | *Aulocystis* | alpine |

**Anthracoidea sempervirentis** Vánky, Bot. Notiser 132: 225, 1979.

Sori in ovaries, spores flattened, moderately polygonal to irregular (Fig. 1 C, D) 15-19 x 17-22(-25) µm in diameter in face view, no internal swelling, wall 1,5-2 µm thick, thickest at the angles, in face view finely verrucose, in SEM surface covered by knobs and rounded, sometimes confluent warts (Fig. 1 D).

HOST: *Carex sempervirens* Vill.

MATERIAL EXAMINED: **Poland**: Carpathians, Tatra Mts, above Lake Morskie Oko, 1957 coll.: B. Starmachowa KRAM 9913.

**Anthracoidea nepalensis** Kakishima & Ono (in Watan. & Malla), Cryptogams of the Himalayas 1:128. 1988

Sori in ovaries, spores globose, subglobose or broadly ellipsoid, slightly irregular, 14-19 x 11-17 µm in diameter in face view; walls dark brown 1-1,5 um thick, internal swellings sporadically observed in some spores, walls minutely verrucose, in SEM surface sparingly covered by petal-like structures (Fig. 1 E, F).

HOST: *C. haematostoma* Nees in Wight, syn.: *Carex nakaoana* T. Koyama (Kakishima & Ono 1988). It is also known on *Carex digyna* (Kük.) T. Tang & S. F. Wang from China.

SPECIMENS EXAMINED: **Nepal**: Langtang valley, Kyangjin Langshisa, alt. 3900 m, 3. September 1986, coll. Y. Ono, IBA-0628 type =TSH-S1025.

## Thian Shan taxon

The *Anthracoidea* species collected in the Thian Shan (KRAM 43553) differs from typical *A. sempervirentis* in having smaller, uniformly situated, rounded or subconical, low warts. *A. sempervirentis* has larger and more irregular spores with thicker wall and surfaces covered by typically confluent and flattened warts (Fig. 1 D). The spores of *A. nepalensis* are larger, darker and more regular than those in the Thian Shan collection (Fig. 1 E, F). The taxon is morphologically more closely related to *A. sempervirentis* than to *A. nepalensis* or *A. misandrae* Kukkonen (Fig. 1 C, D, E, F). It is described as:

***Anthracoidea stenocarpa*** Chleb., sp. nov. Fig. 1 G, H

DIAGNOSIS: *Sporae subglobosae, in visu plano rotundae angulares, leviter irregulares, diametro 15-17(-18) x 14-17 µm, tumores interni desunt, paries crassus 1-1,5 µm. Superficies sporarum sub SEM verrucis dense dispositis, verrucis rotundatis vel subconicis. Holotypus in herb. KRAM depositus, isotypus in Herb. Ustil. Vánky HUV. Differ a* Anthracoidea sempervirentis *sporae minoribus, leviter irregulares et verrucis subconicis.*

DESCRIPTION: Spores subglobose, in plan view rounded angular, slightly irregular 15-17(18) x 14-17 µm in diameter in face view, no internal swellings, walls brown 1-1,5 µm thick. Surface in SEM is provided with densely, uniformly situated, rounded or also subconical to subspinulose, low warts (Fig. 1 G, H).

HOST: *Carex stenocarpa* Turcz. ex V. I. Krecz.

TYPE: **Kazakhstan**: Thian Shan, Dzhungar Alatau Mts., valley of Little Baskan N 45°03'44" E 80°12'12", 3100 m elev., 17 August 2001, in ovaries, coll: L. Nowak-Chlebicka & A. Chlebicki, KRAM 43553 holotype, isotypes in HUV, H.

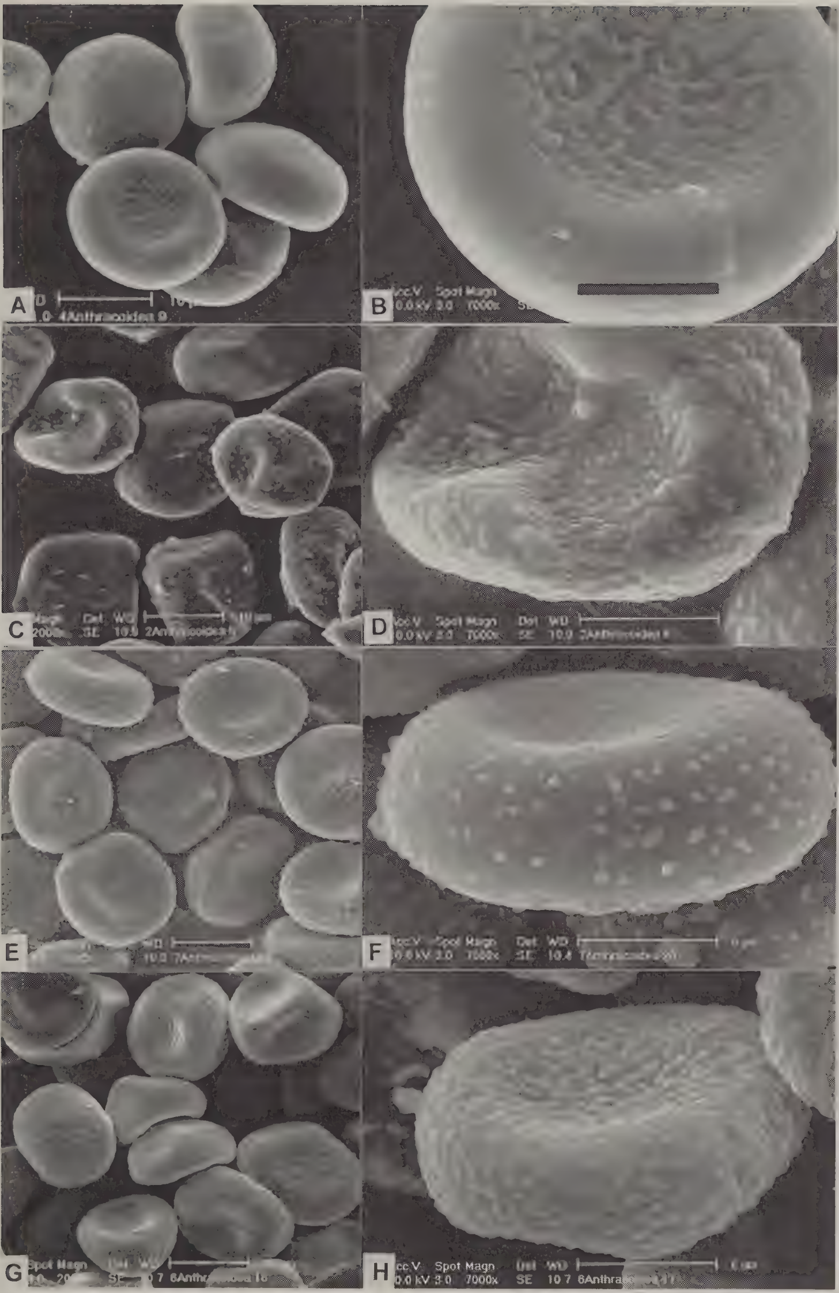
ETYMOLOGY: refers to host plant *Carex stenocarpa*

Fig. 1. A, B. *Anthracoidea elynae* (Syd.) Kukkonen on *Kobresia myosuroides* (Vill.) Fiori & Paol. (KRAM 43554): A - disc shaped spores, B – the concave centre irregularly verrucose with partly confluent warts, margin smooth or finely verrucose.

C, D. *Anthracoidea sempervirentis* Vánky on *Carex sempervirens* Vill. (KRAM 9913): C - irregular and angulate spores, D - rounded warts and knobs.

E, F. *Anthracoidea nepalensis* Kakishima & Ono (in Watan. & Malla), (IBA-0628 type): E - disc shaped spores, F - surface sparingly covered by petal-like structures.

G, H. *Anthracoidea stenocarpa* Chleb.: G - spores slightly angulate, H- surface with densely distributed, rounded or also subconical to subspinose, low warts (KRAM 43553 holotype). A, C, E, G scale bar = 10 µm, B, D, F, H scale bar = 5µm.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## DISCUSSION

Localities of *A. elynae* on *Kobresia myosuroides* reported by Schwarzman (1960) are distributed in the northern ranges of the Thian Shan, e.g., in the Saur Mts. The records of *A. elynae* given by Schwarzman (1960) on *K. humilis* (C. A. Mey. ex Trautv.) Serg. and *K. royleana* Nees ex Boeck. probably have to be referred to *A. lindebergiae* or other *Anthracoidea* sp. (Kukkonen in letter). Spores of *A. elynae* shown by Schwarzman (1960) on *K. capillifolia* are slightly angulate (his drawing 56).

During the Pleistocene, the smut may have been widely distributed together with *Kobresia myosuroides* in the Northern Hemisphere. No differences have been found between Tian Shan smut specimens and those of other areas. Agatova (2002) found traces of two glaciation events in the Middle and Late Pleistocene in the neighboring Altai Mts. Thus the migration route could have been opened at least in the Middle Pleistocene but presence *Kobresia myosuroides* in the Caucasus indicate earlier migration.

The limited distribution of *Anthracoidea stenocarpa* indicates that it belongs to another group of the genus *Anthracoidea*. The smut taxa *A. stenocarpa, A. sempervirentis* and *A. nepalensis* suggest a different pattern of distribution. The European *Carex sempervirens*, Caucasian *C. tristis* and Central Asiatic *C. stenocarpa* may be regarded as members of isolated remnants of the circumpolar Tertiary cryophyte flora or as remnants of the alpine flora of the northern shores of the Tethys Sea (Löve and Löve 1974). *Carex haematostoma* seems to be restricted to the Himalayas and Tibet (Dickoré 1995). Thus the limited distribution of the listed smuts, in mirroring the distributions of their hosts, suggests their relative ages. Neither the plants mentioned nor their smut fungi were distributed in the Arctic during the Pleistocene glaciations. The related smut fungi *A. misandrae* and *A. altera* are arcto-alpine or sub-Arctic in distribution (Nannfeldt 1979, Vánky 1995).

The general distribution of *Carex stenocarpa* is well known due to the work of Meusel et al. (1965), Malyshev et al. (1990), Dickoré (1995), Kukkonen (1998) and Egorova (1999). It extends eastwards to the W. Himalaya (Dickoré 1995). However, its phylogenetic position is not clear. Egorova (1999) considered *C. stenocarpa* to be a race of a related species, the Caucasian sedge *C. tristis* Bieb., which had been described earlier. However *Carex stenocarpa* is situated nearer the center of origin of the genus *Carex*. Kukkonen (1998) recognized *C. stenocarpa* as distinct and separate species. Dietrich (1967) pointed out that *C. sempervirens* is a species complex containing several closely related species. This situation is also found in the Caucasus with *C. tristis* and in Central Asia with *C. stenocarpa* (Kukkonen in letter). Only a single report of *Anthracoidea* ("*A. caricis* (Pers.) Bref.") on *Carex tristis* in Caucasus could be found (Uljanishchev 1968: 57-58). However this fungus name should be applied in a collective sense. The spores which he illustrated (his drawing 55) are irregular, angulate and covered by warts. It is difficult to decide for which *Anthracoidea* species they belong. The Thian Shan *Anthracoidea* seems to be related to *Anthracoidea sempervirentis*. However, distinct differences apparent in the wall structure and shape of spores (Fig. 1 C, D, G, H) may indicate that it is a separate species. Occurrence of such specific parasites strenghtens the opinion that *Carex stenocarpa* is a distinct and independent species. Further investigations of Caucasian and central Asiatic smuts, and comparison of their 18S rDNA gene sequences, would doubtless enable a more precise definition of the phylogeny of the various *Antracoidea-Carex* complexes.

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# TAXONOMIC NOTES ON THE GENUS SEPTORIA IN KOREA (II)

HYEON-DONG SHIN
Division of Environmental Science & Ecological Engineering,
Korea University, Seoul 136-701, Korea
<E-mail: hdshin@korea.ac.kr>
and
EKATERINA F. SAMEVA
Institute of Botany, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria
<E-mail: sameva@iph.bio.bas.bg>

**ABSTRACT:** Twenty species of *Septoria* collected in Korea are listed with descriptions and notes. Of these, *Septoria hibiscicola* sp. nov. on *Hibiscus syriacus* and *S. violae-patrinii* sp. nov. on *Viola patrinii* are described and illustrated in detail. Most species are new records to the fungus flora of Korea.

**Keywords:** *Septoria hibiscicola*, *S. violae-patrinii*, new species, flora.

The present paper continues the investigations on the presence of the genus *Septoria* Sacc. (Sphaeropsidales, Coelomycetes) in Korea. In a previous paper (Shin and Sameva, 1999), 30 species of this genus including 2 new species and 14 new records for Korea were listed. The species reported here were collected by H. D. Shin in Korea between 1989-2000, and the investigation of the specimens was carried out in collaboration by the two authors. A total of 20 species are listed, including 2 new species and 17 new records for Korea.

All collections, including type specimens, are preserved in SMK (Mycological herbarium, Korea University, Korea) and accession numbers are indicated within brackets following each specimen. Duplicates are housed in SOMF (Institute of Botany, Bulgarian Academy of Sciences, Bulgaria).

**(1)** ***Septoria aegopodina*** **Sacc.**, Michelia 1: 185 (1878)

Conidiomata pycnidial, scattered, amphigenous, dark brown, globose, immersed, unilocular, 55-85 µm diam.; ostiole circular, 10-15 µm wide. Conidia holoblastic, filiform to cylindrical, substraight to mildly curved, subtruncate at basal end, tapered gradually towards the obtuse apex, eguttulate, almost hyaline to pale greenish, 20-30×1.8-2.2 μm, mostly 3-septate, occasionally uniseptate, septa more or less indistinct.

Habitat: On living leaves of *Pimpinella brachycarpa* (Kom.) Nakai [= *Cryptotaenia japonica* Hass.] (Umbelliferae).

Specimens examined: SMK 14096 (27 VIII 1997, Pyongchang), 14125 (4 IX 1997, Seoul), 15265 (25 IX 1998, Pyongchang), 16179 (6 VII 1999, Pyongchang),16270 (7 VII 1999, Pyongchang), 16345 (20 VII 1999, Pochon).

Note: Several species of *Septoria* have been described on *Pimpinella* L., and they were segregated by minor differences in conidial size. Brandenburger (1985) considered all to be conspecific with *S. pimpinellae* Laubert.

According to Grove (1935), *S. aegopodina* Sacc. var. *trailii* Grove has aseptate conidia of 20-25×0.8-1.2 μm. The immature conidiomata of our collections also contain aseptate conidia of smaller size. The phenetic characters of our fungus correspond to *S. aegopodina* as described by Vanev *et al*. (1997) and to *S. pimpinellae-saxifragae* Savul. & Sandu as described by Radulescu *et al*. (1973). These two species are very similar and probably conspecific. Until the complicated taxonomic problems of this group of species are answered, we place the Korean collection in *S. aegopodina*. This is the first record of this species from Korea.

**(2) *Septoria agrimoniicola* Bondartsev**, Mat. Myk. Obsled. Ross. 2:6 (1921)

Conidiomata pycnidial, scattered, amphigenous, olivaceous brown to dark brown, globose to depressed globose, immersed, unilocular, 45-65 μm diam. in epiphyllous ones, 55-90 μm diam. in hypophyllous ones; ostiole circular, becoming irregular to radiated at maturity or after releasing conidia, generally large, 20-40(-55) μm wide. Conidia holoblastic, filiform, straight to substraight, subtruncate at basal end, obtuse to subacute at distal end, eguttulate, hyaline, 28-45×1.0-1.5 μm, 1-3-septate, but mostly 2-septate, septa indistinct.

Habitat: On living leaves of *Agrimonia pilosa* Ledeb. (Rosaceae).

Specimens examined: SMK 13850 (27 V 1997, Pyongchang), 15776 (6 V 1999, Pyongchang).

Note: Besides *Septoria agrimoniicola*, *S. agrimoniae-eupatorii* E. Bommer & M. Rousseau was also described on *Agrimonia*. Our specimens are markedly different from the description of the latter (Saccardo, 1892; Radulescu *et al*., 1973), having longer (30-60 μm), wider (2.0-2.5 μm), somewhat flexuous conidia. It is similar with *S. agrimoniicola* recorded from China (Lu *et al*., 1993). This is the first record of this species from Korea.

**(3) *Septoria albopunctata* Cooke**, Grevillea 12: 25 (1883)

Conidiomata pycnidial, scattered, epiphyllous, dark brown, globose, immersed, unilocular, 24-44(-52) μm diam.; ostiole circular to angular, 10-15 µm wide. Conidia holoblastic, filiform, substraight to moderately curved or flexuous, gently tapered towards the distal end, subtruncate at basal end, obtuse at distal end, mostly guttulate, hyaline, greatly variable in length and number of septa, 38-125×1.5-2.5 µm, 1-10-septate, septa more or less distinct.

Habitat: On living leaves of *Vaccinium oldhami* Miq. (Ericaceae).

Specimens examined: SMK 15146 (18 IX 1998, Jinju), 17564 (23 IX 2000, Chonju).

Note: Eight species of *Septoria* have been described on *Vaccinium* spp. *S. albopunctata* is easily distinguishable from the other species by having white conidial tendrils, contrasting with the purple-bordered leaf lesion, when viewed under a dissecting microscope. The conidia are also longer and have more septa than most of the related species. This is the first record of this species from Korea.

### (4) *Septoria alni* Sacc., Michelia 1: 177 (1878)

*Rhabdospora alni* (Sacc.) Kuntze, Rev. Gen. Pl. 3(3): 509, 1898.

Conidiomata pycnidial, scattered, amphigenous, dark brown, globose, immersed, unilocular, 24-78 µm diam.; ostiole circular to subcircular, relatively small, 8-20 µm wide. Conidia holoblastic, filiform, substraight to moderately curved, subtruncate at basal end, obtuse at distal end, guttulate, hyaline, 30-48×2.0-2.5 µm, 2-5-septate, septa distinct.

Habitat: On living leaves of *Alnus hirsuta* (Spach) Rupr. and *A. japonica* Steud. (Betulaceae).

Specimens examined: On *A. hirsuta*, SMK 10217 (22 IX 1989, Kangnung), 10961 (28 VIII 1991, Kangnung), 12296 (27 X 1992, Kangnung), 13086 (28 IX 1994, Kangnung), 14960 (29 VIII 1998, Seoul); on *A. japonica*, SMK 18038 (30 X 2000, Jinju).

Note: Seven species of *Septoria* have been described on *Alnus* spp. Constantinescu (1984) revised the taxonomy of these fungi and accepted three of them, including *S. alni*. This species has been recorded by many authors, and is well known as a leaf spot producing fungus on *Alnus* spp. In Korea, it was first listed by Park (1967) without description, and by Forestry Research Institute (1991) with short description (pycnidia 60-180 µm diam., conidia 18-54×1.5-3.0 µm). The size given for conidiomata is, however, unusually large.

### (5) *Septoria apiicola* Speg., Fungi Fuegiani, Bol. Acad. Nac. Cienc. Cordoba 11: 294 (1887)

Conidiomata pycnidial, scattered or closely grouped, amphigenous, rusty brown to brown, globose, immersed, unilocular, 90-175 µm diam.; ostiole circular, very large, 42-90 µm wide. Conidia holoblastic, filiform to acicular, substraight to mildly curved, obconically truncate at basal end, obtuse at distal end, guttulate or eguttulate, hyaline, 25-45×2.0-2.5 µm, 3-5-septate, septa distinct.

Habitat: On living leaves of *Apium graveolens* L. (Umbelliferae).

Specimens examined: SMK 13162 (9 X 1994, Pyongchang), 13757 (11 V 1997, Namyangju), 13759 (11 V 1997, Namyangju), 13968 (15 VI 1997, Namyangju).

Note: *Septoria apiicola* is a well known pathogen of celery producing the leaf spot. The taxonomy and nomenclature of *Septoria* on *Apium* spp. was elucidated by Gabrielson and Grogan (1964) and their decision was accepted by subsequent authors (Farr *et al*., 1989; Lu, 1992; Vanev *et al*., 1997). *S. apiicola* was recorded for the first time in Korea by Park (1967), without providing a description, and recently Cho *et al*. (1997) published a short note based on Korean material.

**(6) *Septoria bupleuricola* (Thüm.) Sacc.**, Syll. Fung. 3: 529 (1884)

Conidiomata pycnidial, scattered, mostly epiphyllous, but rarely also hypophyllous, dark brown to brown, globose to depressed globose, immersed, unilocular, 56-108 µm diam.; ostiole circular, relatively small, 10-36 µm wide. Conidia holoblastic, filiform, straight to substraight, obtuse at both ends, sometimes pointed at distal end, eguttulate, hyaline, 15-38×1.5-2.5 µm, 1-4-septate, septa indistinct.

Habitat: On living leaves of *Bupleurum falcatum* L. and *B. longiradiatum* Turcz. (Umbelliferae).

Specimens examined: On *B. falcatum*, SMK 14088 (27 VIII 1997, Pyongchang), 15407 (8 X 1998, Suwon); on *B. longiradiatum*, SMK 11920 (6 IX 1992, Pyongchang), 12545 (18 VIII 1993, Pyongchang).

Note: Lee *et al*. (1991) recorded *Septoria* sp. on *B. longiradiatum*, providing a brief description (conidiomata pycnidial; conidia 1-3-septate, 20-40×2-3 µm). These characters agree with the fungus found by us. This is the first record of this species from Korea.

**(7) *Septoria cerastii* Roberge ex Desm.**, Ann. Sci. Nat. Bot., ser. III, 11: 347 (1849)

Conidiomata pycnidial, scattered to partly aggregated, amphigenous, but mostly epiphyllous, dark brown to brown, globose to depressed globose, immersed to partly protuberate, unilocular, 50-130 µm diam.; ostiole circular to irregular, 20-45 µm wide. Conidia holoblastic, filiform, straight to mildly curved, gently tapered towards the both ends, subtruncate at basal end, subacute at distal end, eguttulate, hyaline, 25-52×1.5-2.0 µm, (1-)2-4-septate, septa more or less indistinct.

Habitat: On living leaves of *Cerastium holosteoides* var. *hallaisanense* Mizushima (Caryophyllaceae).

Specimens examined: SMK 15574 (27 X 1998, Seoul), 15699 (27 IV 1999, Seoul), 15721 (2 V 1999, Chunchon), 15820 (20 V 1999, Pochon), 17299 (12 V 2000, Pyongchang), 17313 (16 V 2000, Seoul), 17330 (18 V 2000, Hongchon), 17342 (19 V 2000, Seoul), 17387 (6 VI 2000, Namyangju).

Note: *Septoria cerastii* is a well-known and world-wide distributed fungus (Grove, 1935; Jørstad, 1965; Radulescu *et al.*, 1973; Teterevnikova-Babayan, 1987; Vanev *et al.*, 1997). This is the first record of this species from Korea.

**(8) *Septoria clinopodii* Allesch.**, Ber. Bayer. Bot. Ges. 5: 20 (1897)

Conidiomata pycnidial, scattered, amphigenous, but mostly hypophyllous, dark brown to brown, globose to depressed globose, immersed, unilocular, 45-80 μm diam.; ostiole circular to irregular, 20-38 μm wide. Conidia holoblastic, filiform, substraight to moderately curved, obconically subtruncate at basal end, subobtuse at distal end, guttulate, hyaline, variable in length and number of septa, 28-75×1.5-2.0 μm, 2-7(-9)-septate, septa distinct.

Habitat: On living leaves of *Clinopodium chinense* var. *parviflorum* (Kudo) Hara (Labiatae).

Specimens examined: SMK 15301 (1 X 1998, Suwon), 17644 (24 IX 2000, Chongju).

Note: Except for some minor differences in conidia size, the phenetic characters indicated by various authors (Radulescu *et al.*, 1973; Lu, 1992; Lu *et al.*, 1993; Vanev *et al.*, 1997), do not vary much. *Septoria clinopodii* Allesch. var. *longispora* D.N. Babayan & Savintz. (fide Teterevnikova-Babayan, 1987), has larger conidiomata (100-120 μm diam.) and thin, clavate conidia with blunt ends, 3-4-septate, 34-56×1.5-2.5 μm. This is the first record of this species from Korea.

**(9) *Septoria crepidis* Vestergr.**, Bihang K. Svenska V.A. Handl. XXII, Afd. III, 6: 24 (1896)

Conidiomata pycnidial, scattered, amphigenous, but mostly epiphyllous, brown to dark brown, globose, immersed, unilocular, 54-90 μm diam.; ostiole subcircular to somewhat angular, 16-28 μm wide. Conidia holoblastic, filiform, straight to substraight, long obconically subtruncate at basal end, gently tapered towards the narrowly obtuse distal end, eguttulate, hyaline to subhyaline, 24-45(-56) ×1.5-2.0 μm, 2-4-septate, septa more or less distinct.

Habitat: On living leaves of *Youngia japonica* (L.) DC. [= *Crepis japonica* (L.) Benth.] (Asteraceae).

Specimens examined: SMK 11366 (22 X 1991, Kangnung), 11486 (6 XI 1991, Kangnung), 11614 (28 V 1992, Kangnung), 12395 (12 V 1993, Kangnung), 12779 (21 V 1994, Kangnung), 12824 (2 VI 1994, Kangnung), 13342 (5 XI 1994, Suwon), 13779 (17 V 1997, Seoul), 13780 (19 V 1997, Seoul), 13835 (26 V 1997, Samchok), 14482 (27 IV 1998, Seoul), 15653 (13 XI 1998, Suwon), 15702 (27 IV 1999, Seoul), 15705 (28 IV 1999, Suwon), 15717 (1 V 1999, Seoul), 15873 (27 V 1999, Seoul), 15981 (5 VI 1999, Seoul), 17279 (11 V 2000, Samchok), 17366 (1 VI 2000, Seoul), 17431 (15 VI 2000, Chonju), 17529 (9 IX 2000, Seoul), 18153 (21 XI 2000, Cheju).

Note: According to the original description of this species (Saccardo, 1899), and to Radulescu *et al.* (1973), the conidia are filiform, straight to somewhat curved, becoming narrower towards both ends, 25-35×1 μm, hyaline and septate. The conidia described by Teterevnikova-Babayan (1987) are larger (25-40×1.5-2 μm), and have some indistinct septa. These last characteristics match closely those we found in the Korean collections. This is the first record of this species from Korea.

**(10)** ***Septoria dearnessii*** **Ellis & Everh.**, J. Mycol. 5: 151 (1889)

Conidiomata pycnidial, scattered, amphigenous, but chiefly hypophyllous or epiphyllous, dark brown, globose, immersed, unilocular, 36-100 μm diam.; ostiole circular to irregular, 18-35 μm wide. Conidia holoblastic, filiform, straight to moderately curved, subtruncate at basal end, tapered gradually towards the narrowly obtuse distal end, eguttulate, sometimes guttulate, hyaline, 18-36(-48) ×1.5-2.0(-3.0) μm, 1-3(-4)-septate, septa distinct.

Habitat: On living leaves of *Angelica dahuruca* (Fisch.) Benth. and *Ostericum koreanum* (Max.) Kitagawa [= *Angelica koreana* Max.] (Umbelliferae).

Specimens examined: On *A. dahurica*, SMK 15422 (9 X 1998, Chunchon), 16101 (24 VI 1999, Suwon), 16501 (25 VIII 1999, Suwon), 17493 (5 IX 1999, Suwon), 18007 (30 X 2000, Jinju); on *O. koreanum*, SMK 12986 (12 IX 1994, Suwon), 14804 (19 VIII 1998, Chunchon), 15252 (25 IX 1998, Pyongchang), 15275 (25 IX 1998, Pyongchang).

Note: Several species of *Septoria* are known on the genus *Angelica* s. lat. Angular leaf spot as small as 1-3 mm diam., small conidiomata and relatively short conidia seem to be characteristic for this species (Saccardo, 1892; Lu, 1992). This is the first record of this species from Korea.

**(11)** ***Septoria dysentericae*** **Brun.**, Sphaerops. Charent., p. 81 (1889)

Conidiomata pycnidial, scattered, epiphyllous, dark brown, globose, immersed, unilocular, 55-100 μm diam.; ostiole circular to subcircular, becoming irregular after releasing spores, 15-45 μm wide. Conidia holoblastic, filiform, substraight to mildly curved, subtruncate at basal end, gently tapered towards the apex, subacute at distal end, guttulate but sometimes eguttulate, hyaline, 25-56×2.0-2.5 μm, 3-8-septate, septa distinct.

Habitat: On living leaves of *Inula britannica* var. *chinensis* Regel (Asteraceae).

Specimens examined: SMK 14361 (4 X 1997, Seoul), 14942 (28 VIII 1998, Seoul), 16043 (19 VI 1999, Seoul), 16486 (25 VIII 1999, Suwon), 16724 (13 IX 1999, Pyongchang).

Note: The characters of the fungus in our collections agree with previous records of *S. dysentericae* (Radulescu *et al.*, 1973; Lu, 1992; Vanev *et al.*, 1997). This is the first record of this species from Korea.

**(12)** ***Septoria helianthi*** **Ellis & Kellerm.**, Amer. Naturalist, p. 1165 (1883)

Conidiomata pycnidial, scattered, epiphyllous, dark brown, globose to depressed globose, immersed, unilocular, 80-170 µm diam.; ostiole subcircular to irregular, very large, 45-100 µm wide. Conidia holoblastic, filiform, substraight to curved, obconically subtruncate at basal end, narrowly obtuse at distal end, eguttulate, hyaline, 40-88×2.5-3.5 µm, 2-5-septate, septa distinct.

Habitat: On living leaves of *Helianthus annuus* L. (Asteraceae).

Specimens examined: SMK 13812 (25 V 1997, Chunchon), 14709 (3 VII 1998, Yangku), 15287 (1 X 1998, Suwon), 15911 (29 V 1999, Chunchon), 16429 (24 VIII 1999, Chunchon).

Note: Chung *et al*. (1977) listed this fungus for the first time in Korea but provided no description.

**(13)** ***Septoria hibiscicola*** **H.D. Shin & Sameva sp. nov.** **Fig. 1**

Conidiomata pycnidialia, sparsa, amphigena, plerumque epiphylla, atrobrunnea, globosa, immersa, unilocularia, 60-105 µm diam.; ostiolum irregulare, 25-45 µm latum. Cellulae conidiogenae sympodiales, lageniformes usque ampulliformes, hyalinae, 6-15×2.5-3.5 µm. Conidia holoblastica, filiformia, suberecta usque curvata, basi subtruncata usque subobtusa, versus apicem anguste obtusum sensim angustata, interdum ad septa leniter constricta, hyalina, guttulata usque eguttulata, 24-105×2.5-3.5 µm, (1-)2-9(-13)-septata; septa distincta.

Conidiomata pycnidial, scattered, amphigenous, but mostly epiphyllous, dark brown, globose, immersed, unilocular, 60-105 µm diam.; ostiole irregular, 25-45 µm wide. Conidiogenous cells sympodial, lageniform to ampulliform, hyaline, 6-15×2.5-3.5 µm. Conidia holoblastic, filiform, substraight to curved, subtruncate to subobtuse at basal end, tapered gradually towards the narrowly obtuse distal end, occasionally mildly constricted at the septa, hyaline, guttulate to eguttulate, variable in length and number of septa, 24-105×2.5-3.5 µm, (1-)2-9(-13)-septate, septa distinct.

Holotypus: In foliis vivis *Hibisci syriaci* L. (Malvaceae). Yangku, Korea, Shin, 14 IX 1997 (SMK 14159).

Additional specimens examined: SMK 14453 (17 X 1997, Youngwol), 14620 (7 VI 1998, Yangku), 14763 (13 VIII, Yangku), 15337 (4 X 1998, Yangku), 15349 (4 X 1998, Yangku), 16736 (17 IX 1999, Wonju), 17689 (29 IX 2000, Hongchon).

Note: *Septoria hibiscicola* is quite different from *S. hibisci* Sacc. (cf. Saccardo, 1884), also parasitic on *Hibiscus syriacus*, in having smaller (50-60 µm diam.) conidiomata, and much shorter (15-20×2-2.5 µm) conidia.

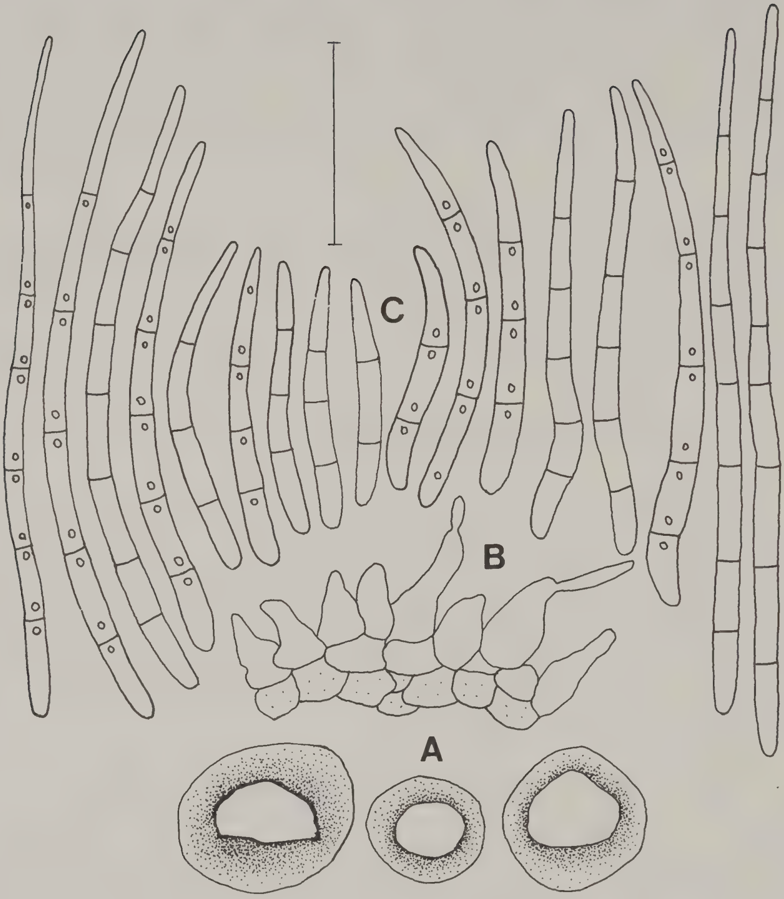

**Fig. 1.** *Septoria hibiscicola* H.D. Shin & Sameva: **A**, Conidiomata. **B**, Conidiogenous cells and developing conidia. **C**, Conidia. Scale bar = 100 µm for **A** and 20 µm for **B** & **C**. (H.D. Shin del.)

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There are two more species described from *Hibiscus rosa-sinensis* L.: *S. simillima* Thüm. has aseptate, short conidia of 12-16×2-2.5 µm (Brandenburger, 1985). It is very similar and probably conspecific with *S. hibisci*. *S. rosae-sinensis* Brunaud differs from our fungus in having hypophyllous conidiomata and shorter, very thin, aseptate conidia of 22-25×1-1.5 µm (Saccardo, 1892). There is no comparable *Septoria* species having such long conidia on any genus of the Malvaceae. Therefore, this fungus is considered as a new, undescribed species.

**(14)** ***Septoria hydrocotyles*** **Desm.**, Ann. Sci. Nat. Bot., ser. II, 17: 109 (1842)

Conidiomata pycnidial, scattered, amphigenous, but mostly epiphyllous, dark brown, globose, immersed, unilocular, 60-110 µm diam.; ostiole circular to subcircular, 10-25 µm wide. Conidia holoblastic, filiform, straight to mildly curved, subtruncate at basal end, tapered gradually towards the apex, obtuse to subacute at distal end, guttulate, hyaline, 16-30×1.5-2.0 µm, 1-3-septate, septa distinct, issuing as whitish tendrils.

Habitat: On living leaves of *Hydrocotyle ramiflora* Max. (Umbelliferae).

Specimens examined: SMK 17601 (23 IX 2000, Chonju).

Note: Of the four species of *Septoria* described on *Hydrocotyle* spp., *S. spegazzini* Sacc. (Saccardo, 1884) differs by having longer conidia (45-50×1.5 µm), and *S. hydrocotylicola* Speg. with conidia of 40-50×1 µm. *S. pallidula* Dearn. & House is characterized by having small (60-65 µm) conidiomata and eguttulate conidia. The Korean collection matches *S. hydrocotyles* in having short, guttulate, 1-3-septate conidia (Saccardo, 1884). This is the first record of this species from Korea.

**(15)** ***Septoria lophanthi*** **G. Winter**, Hedwigia, p. 71 (1883)

Conidiomata pycnidial, scattered, amphigenous, but mostly epiphyllous, dark brown to brown, globose, immersed, unilocular, 60-100 µm diam.; ostiole circular to subcircular, but becoming irregular to radiated at maturity or after releasing conidia, 15-20(-40) µm wide. Conidia holoblastic, filiform, substraight to somewhat curved, sometimes flexuous, obtuse to subtruncate at basal end, gently tapered towards the apex, obtuse to subacute at distal end, guttulate, hyaline to subhyaline, 25-62×2-2.5 µm, 2-7-septate, septa distinct.

Habitat: On living leaves of *Agastache rugosa* (Fisch. & Meyer) O. Kuntze (Umbelliferae).

Specimens examined: SMK 15124 (18 IX 1998, Jinju), 15289 (1 X 1998, Suwon), 17502 (5 IX 2000, Suwon), 17994 (29 X 2000, Jinju).

Note: This fungus is the only *Septoria* described on *Agastache*. The morphological characters of taxonomic value for this species had been poorly known (Saccardo, 1884; Greene, 1957). Lu (1992) provided a detailed description based on Chinese specimens on *A. rugosa*. The Korean collections agree with his data. This is the first record of this species from Korea.

**(16)** ***Septoria napelli*** **Speg.**, Nov. Add., no. 162 (1879)

Conidiomata pycnidial, scattered or partly aggregated, epiphyllous, rarely also hypophyllous, dark brown, globose to depressed globose, immersed, unilocular, (80-)100-240 µm diam.; ostiole circular to irregular, sometimes radiated, (30-)45-90 µm wide. Conidia holoblastic, filiform, substraight to vermicular, sometimes sickle-shaped, obconically truncate at basal end, gradually tapered towards the obtuse distal end, guttulate, subhyaline to pale greenish, 50-105×2.5-4.0 µm, 3-9-septate, septa distinct.

Habitat: On living leaves of *Aconitum ciliare* DC., *A. longecassidatum* Nakai and *A. pseudo-laeve* var. *erectum* Nakai (Ranunculaceae).

Specimens examined: On *A. ciliare*, SMK 16347 (20 VII 1999, Pochon); on *A. longecassidatum*, SMK 14124 (4 IX 1997, Seoul); on *A. pseudo-laeve* var. *erectum*, SMK 13847 (27 V 1997, Pyongchang), 15065 (8 IX 1998, Seoul), 15948 (3 VI 1999, Pochon), 16336 (20 VII 1999, Pochon), 17133 (21 X 1999, Pochon), 17767 (3 X 2000, Pyongchang).

Note: Petrak (1957) examined and discussed the five species of *Septoria* recorded on *Aconitum* spp. He made the combination *Rhabdospora napelli* (Speg.) Petrak, that was accepted by Brandenburger (1985). However, Radulescu *et al.* (1973), Teterevnikova-Babayan (1987), and Vanev *et al.* (1997) preferred to use Spegazzini's name. Another species, *S. lycoctoni* Speg. (= *S. vulpariae* Hollós) differs from *S. napelli* by having narrower conidia of 20-60(-80)×1.5-2 μm (Brandenburger, l.c.). This is the first record of this species from Korea.

**(17)** ***Septoria stachydicola*** **(Bubák ex Serebrian.) Jacz.**, Opredelitel gribov 2: 114 (1917)

*Phlyctaena stachydicola* Bubák ex Serebrian., 1912.

Conidiomata pycnidial, scattered, amphigenous, but mostly epiphyllous, dark brown, globose, immersed, unilocular, 40-80 μm diam.; ostiole circular to somewhat irregular, 20-36 μm wide. Conidia holoblastic, filiform, substraight to somewhat curved, obconically truncate to subtruncate at basal end, gradually tapered towards the narrowly obtuse distal end, hyaline, guttulate, usually with 2 oil drops in each cell, 38-72×2.0-3.0 μm, 3-7-septate, septa distinct, but occasionally some septa indistinct.

Habitat:On living leaves of *Stachys roedero* var. *japonica* Miq. (Labiatae).

Specimens examined: SMK 14028 (25 VIII 1997, Pyongchang), 14029 (25 VIII 1997, Pyongchang).

Note: Jørstad (1965) considered that several species of *Septoria* parasitic on Lamiaceae (= Labiatae) resemble each other considerably and probably at least some of them ought to be amalgamated. Recently, Vanev *et al.* (1997) described 21 species of *Septoria* on different genera of Lamiaceae from Bulgaria, two of them on *Stachys*. Most authors have identified *Septoria* on *Stachys* as *S. stachydis* Roberge ex Desm. (Grove, 1935; Jørstad, 1965; Radulescu *et al.*, 1973; Vanev *et al.*, 1997), although the measurements of conidia given by them vary: the length up to 50 μm and the width not more than 2.0 μm. *Septoria stachydicola* differs from *S. stachydis* by having longer and wider conidia of 35.5-76.5×2.2-3.2 μm (Sameva and Vanev, 1987). This is the first record of this species from Korea.

**(18)** ***Septoria tinctoriae*** **Brunaud**, Misc. Mycol. 44(2): 37 (1890)

Conidiomata pycnidial, scattered, amphigenous, but mostly epiphyllous, brown to dark brown, globose to depressed globose, immersed, unilocular, 38-80(-110) μm diam.; ostiole circular, 10-24 μm wide, surrounded by small dark cells. Conidia holoblastic, filiform, straight to mildly curved, subobtuse to subtruncate at basal end, tapered gradually towards the subobtuse distal end, eguttulate or sometimes guttulate, hyaline to subhyaline, 25-55×1.5-2(-2.5) μm, 2-7-septate, septa distinct.

Habitat: On living leaves of *Serratula coronata* var. *insularis* Kitamura (Asteraceae).

Specimens examined: SMK 12566 (20 VIII 1993, Suwon), 12605 (3 IX 1993, Suwon), 12974 (12 IX 1994, Suwon), 17517 (5 IX 2000, Suwon).

Note: This is the only species of *Septoria* described on *Serratula*. The morphological characters of our specimens agree with the previous records of this species (Cejp and Jechova, 1967; Radulescu *et al.*, 1973; Brandenburger, 1985; Teterevnikova-Babayan, 1987; Vanev *et al.*, 1997). This is the first record of this species from Korea.

**(19) *Septoria tormentillae* Roberge ex Desm.**, Ann. Sci. Nat. Bot., ser. III, 8: 82 (1847)

Conidiomata pycnidial, scattered, amphigenous, but mostly epiphyllous, grown, depressed globlose, partly immersed, unilocular, 64-104 μm diam.; ostiole at first angular to linear, becoming irregular to radiated at maturity or after releasing conidia, large, 40-82 μm wide. Conidia holoblastic, filiform, substraight to mildly curved, subtruncate to subobtuse at basal end, subacute to narrowly subobtuse at distal end, eguttulate, hyaline to subhyaline, 24-54×1.4-2.0 μm, 2-5(-7)-septate, but abundantly 3-septate, septa distinct.

Habitat: On living leaves of *Potentilla fragarioides* var. *major* Max., *P. freyniana* Bornm., and *P. yokusiana* Makino (Rosaceae).

Specimens examined: On *P. fragarioides* var. *major*, SMK 12405 (6 VI 1993, Pyongchang), 13545 (16 VI 1995, Kangnung), 13862 (27 V 1997, Pyongchang), 14001 (12 VIII 1997, Seoul), 14064 (27 VIII 1997, Pyongchang), 14600 (4 VI 1998, Seoul), 14635 (7 VI 1998, Chunchon), 14802 (19 VIII 1998, Chunchon), 15731 (2 V 1999, Kapyong), 16621 (5 IX 1999, Seoul), 16690 (13 IX 1999, Pyongchang), 17411 (9 VI 2000, Pyongchang); on *P. freyniana*, SMK 15844 (23 V 1999, Yangku); on *P. yokusiana*, SMK 15769 (6 V 1999, Kangnung).

Note: Several species of *Septoria* have been recorded on *Potentilla* spp. Lu *et al.* (1993) reduced *S. sparsa* Fuckel and *S. corcontica* Kabát & Bubák with narrow (less than 2 μm) conidia to synonyms of *S. tormentillae*. They also suggested that *S. potentillica* Thüm., *S. purpurascens* Ellis & G. Martin and *S. fragariae* Desm. with broad (2.5-4.0 μm) conidia may be conspecific. Our specimens match the characters of *S. tormentillae* as described in previous records (Grove, 1935; Jørstad, 1965; Radulescu *et al.*, 1973; Teterevnikova-Babayan, 1987; Lu *et al.*, 1993; Vanev *et al.*, 1997). This is the first record of this species from Korea.

### (20) *Septoria violae-patrinii* H.D. Shin & Sameva sp. nov. **Fig. 2**

Conidiomata pycnidialia, vel sparsa vel in circulos concentricos dispositi, amphigena, atrobrunnea usque brunnea, globosa usque depresso-globosa, immersa, unilocularia, 54-144 µm diam.; ostiolum circulare vel ellipticum, 15-62 µm latum. Cellulae conidiogenae sympodiales, lageniformes vel ampulliformes, hyalinae, 6-15×2.5-4.5 µm. Conidia holoblastica, acerosa vel bacilliformia, versus apices sensim angustata, basi subobtusa, in apicem distalem subobtusa usque subacuta, eguttulata, subhyalina, 14-25×1.5-2.0(-2.5) µm, 1-2(-3)-septata; septa indistincta.

Conidiomata pycnidial, scattered or arranged in concentric circles, amphigenous, dark brown to brown, globose to depressed globose, immersed, unilocular, 54-144 µm diam.; ostiole circular or elliptical, 15-62 µm wide. Conidiogenous cells sympodial, lageniform or ampulliform, hyaline, 6-15× 2.5-4.5 µm. Conidia holobalstic, acerose to bacilliform, gradually tapered towards the both ends, subobtuse at basal end, subobtuse to subacute at distal end, eguttulate, subhyaline, 14-25×1.5-2.0(-2.5) µm, 1-2(-3)-septate, septa indistinct.

Holotypus: In foliis vivis *Violae patrinii* DC. (Violaceae). Chunchon, Korea, Shin, 21 IX 1991 (SMK 11104).

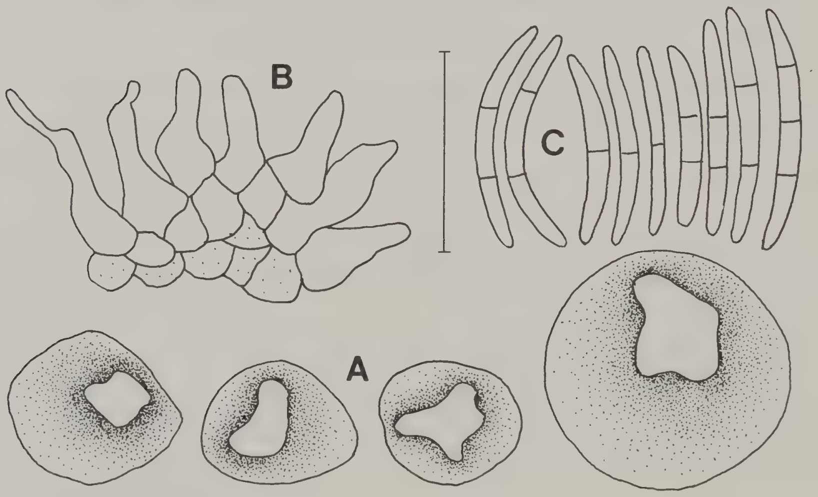

**Fig. 2.** *Septoria violae-patrinii* H.D. Shin & Sameva: **A**, Conidiomata. **B**, Conidiogenous cells and developing conidia. **C**, Conidia. Scale bar = 100 µm for **A** and 20 µm for **B** & **C**. (H.D. Shin del.)

Additional specimens examined: SMK 11737 (28 VI 1992, Chunchon), 13261 (29 X 1994, Chunchon), 17551 (12 IX 2000, Hwachon).

Note: The present fungus is clearly different from *S. violae-palustis* (cf. Shin & Sameva, 1999). There is no comparable *Septoria* species having 1-2(-3)-septate, short conidia on *Viola* and related genera of the Violaceae. Therefore, this fungus is considered as a new, undescribed species.

## ACKNOWLEDGEMENTS

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# MORPHOLOGY OF PENICILLATE CELLS IN THE GENUS PHYLLACTINIA AND ITS TAXONOMIC APPLICATION

**HYEON-DONG SHIN**
Division of Environmental Science and Ecological Engineering,
Korea University, Seoul 136-701, Korea
<E-mail: hdshin@korea.ac.kr>
and
**HYUN-JUNG LEE**
Department of Agricultural Biology, Graduate School,
Korea University, Seoul 136-701, Korea
<E-mail: hyunjunglee@korea.ac.kr>

**ABSTRACT:** The morphological characteristics of penicillate cells in the genus *Phyllactinia* have been poorly studied. Careful microscopic examinations revealed that their morphological features are fairly consistent in particular species and sufficiently different from each other to be used for species delimitation in combination with other characters of taxonomic value.

**Keywords:** powdery mildews, Erysiphaceae, species delimitation

*Phyllactinia* Lév. belongs to the Erysiphaceae (Erysiphales, Ascomycota) and is a well-known genus of phytopathogenic fungi causing powdery mildew mostly on the lower leaf surface of woody plants. This taxon is characterized by having large ascomata, acicular appendages with bulbose swellings at the base, 2(-3)-spored asci, large ascospores, and gelatinous penicillate cells on their ascomata (Braun, 1987). The species delimitation in this genus has been based on host family or genus, number of appendages per ascoma, number of ascospores per ascus, and some other morphometric data found in their teleomorphic states (Braun, 1987; Zheng and Yu, 1987; Shin, 1988; Nomura, 1997). Chinese mycologists (Yu and Han, 1978; Yu and Lai, 1979; Yu *et al.*, 1979) divided this taxon into two groups; viz., one with short ascomatal appendages and the other with long appendages. Recently Shin (2000) suggested that the anamorphic characteristics are different amon species of this genus and could be used for species delimitations.

This genus is unique in the Erysiphaceae by having penicillate cells on the upper part of the ascomata. The penicillate cells of *Phyllactinia* are composed of foots and filaments. The foots are mostly cylindrical, hyaline, nonseptate outgrowths of the ascomatal walls. The filaments arise from the upper part of the foots, are able to gelify by absorbing water and are supposed to serve as structures by which the ascomata may be adhered to their substrates like leaves, branches of trees, etc. (Yarwood, 1957). Though the penicillate cells have been described and drawn by some authors (Homma, 1937; Yu and Han, 1978; Yu and Lai, 1979; Yu *et al.*, 1979; Shin, 1988; Nomura, 1997), their morphological characteristics have been rather poorly studied and never used for taxonomic purposes.

Shin (1988) already suggested that the penicillate cells differ among species of *Phyllactinia* collected in Korea, but since the penicillate cells are small and hyaline, detailed light microscopic examinations of these structures, based on samples mounted in water or lactic acid, were not successful. To cope with these problems, the samples were stained with lactofuchsin (Charmichael, 1955) and heated with a small flame (Shin, 1990, modified). This method was successful for precise examinations of the penicillate cells and revealed that their morphological features are fairly consistent in particular species (Figs 1 and 2).

A total of 15 species of *Phyllactinia* were examined in this work. Most specimens were collected in Korea by H.D. Shin and maintained in the mycological herbarium SMK (Korea University, Seoul, Korea) and some specimens were obtained from SOMF (Institute of Botany, Bulgarian Academy of Sciences, Sofia, Bulgaria).

It is hoped that this study will stimulate further examinations of the morphological characteristics of the penicillate cells in additional species of *Phyllactinia*.

### 1. *Phyllactinia aceris* H.D. Shin & Y.J. La **Fig. 3**

**Penicillate cells:** Foots cylindrical, irregular in width, 20-42(-48)×7.5-14 µm, not divided in the upper part or occasionally bifurcate into short cylindrical branchlets; filaments 15-38 µm, generally similar in length to the foots, 2-4 µm wide.

**Host:** *Acer mandshuricum* Max.

**Materials examined:** SMK 10096 (24 X 1987, Suwon), 10127 (22 IX 1988, Suwon), 10223 (23 IX 1989, Suwon), 14448 (17 X 1998, Suwon), 16913 (4 X 1999, Suwon), 16924 (4 X 1999, Suwon), 17216 (8 XI 1999, Suwon).

**Note:** This species is characterized by having relatively short conidiophores with twisted to flexuous basal cells (Shin, 2000). The penicillate cells of this species were rather short and small among *Phyllactinia* spp. examined in this study.

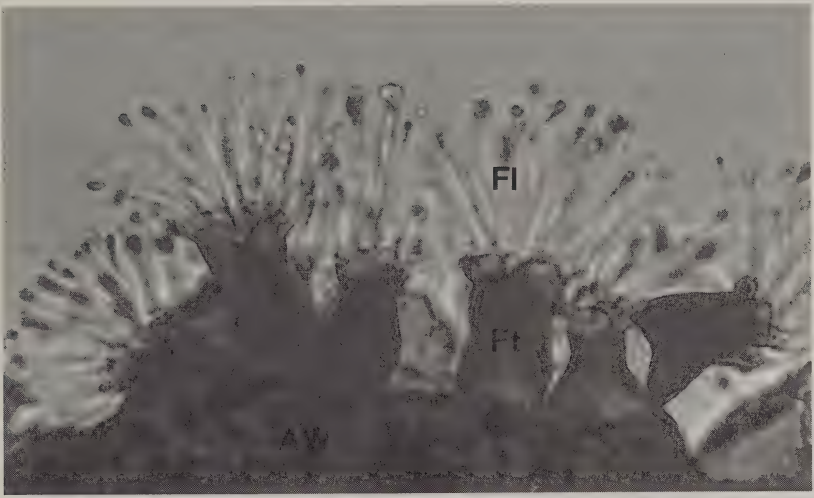

**Fig. 1.** Photomicrograph of the penicillate cells on ascomatal walls (AW) of *Phyllactinia corni*. Note the short foots (Ft) divided into several bulbose branchlets in the upper part and the filaments (Fl) on the foots. It was stained with lactofuchsin by heating.

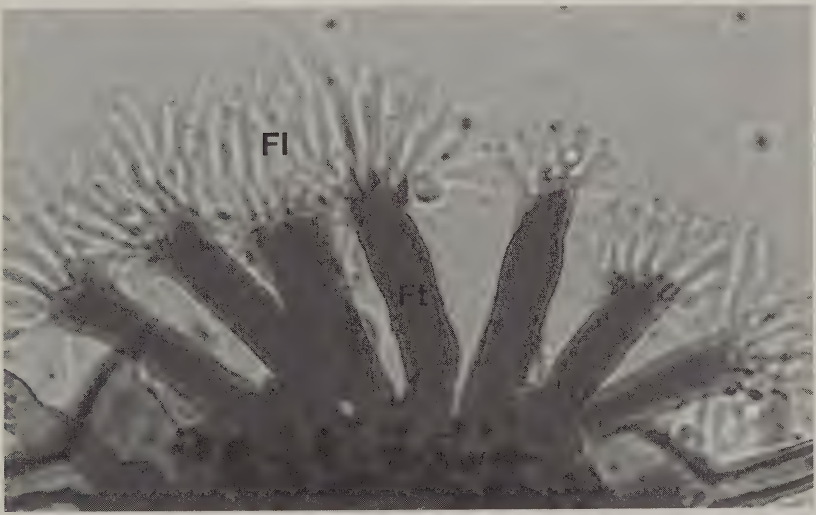

**Fig. 2.** Photomicrograph of the penicillate cells on ascomatal walls (AW) of *Phyllactinia* sp. on *Juglans mandshurica*. Note the long foots (Ft) divided into several short branchlets in the upper part and the filaments (Fl) on the foots. It was stained with lactofuchsin by heating.

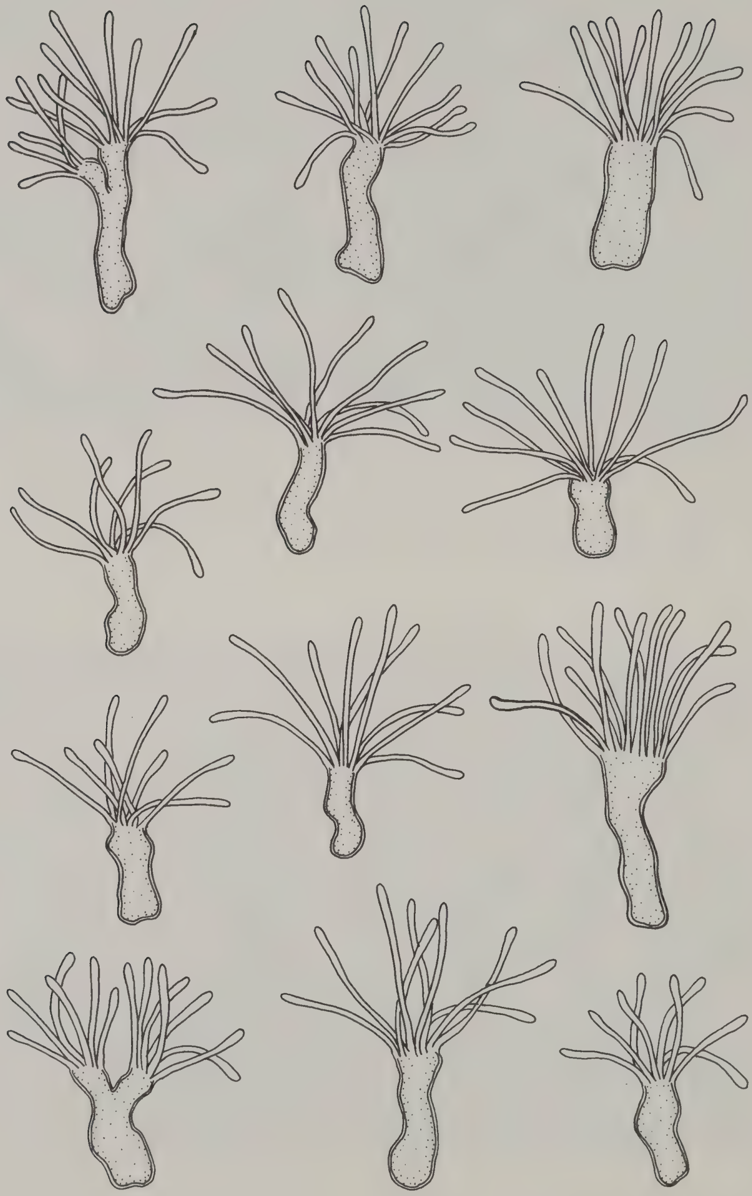

**Fig. 3.** Penicillate cells of *Phyllactinia aceris* on *Acer mandshuricum*.

**2.** ***Phyllactinia ailanthi*** **(Golovin & Bunkina) Y.N. Yu** **Fig. 4**

**Penicillate cells:** Foots cylindrical, irregular in width, (25-)36-64×7.5-15 (-20) μm, divided into 2-8 branchlets in the upper part, occasionally neither branched nor bifurcate at the base; filaments 15-45 μm, generally shorter than the foots, 2-4 μm wide.

**Host:** *Ailanthus altissima* Swingle

**Materials examined:** SMK 10028 (29 IX 1987, Suwon), 10126 (22 IX 1988, Suwon), 10669 (7 XI 1990, Kangnung), 11269 (9 X 1991, Kangnung), 11365 (22 X 1991, Kangnung), 12074 (6 X 1992, Kangnung), 12131 (10 X 1992, Kangnung), 12230 (21 X 1992, Kangnung), 12247 (21 X 1992, Kangnung), 14402 (11 X 1997, Seoul), 16779 (17 IX 1999, Wonju), 17042 (13 X 1999, Seoul), 17184 (27 X 1999, Seoul), 17193 (29 X 1999, Andong), 17201 (7 XI 1999, Seoul).

**Note:** The penicillate cells of this species were illustrated by Zheng and Yu (1987) and Shin (1988). Recently Nomura (1997) described the penicillate cells as 55-75 μm in total length, foots 30-40×10-17.5 μm, bifurcate or divided into several branchlets in the upper part of foots, filaments somewhat shorter than the foots. These previous records agree well with the present observation.

**3.** ***Phyllactinia alni*** **Y.N. Yu & S.J. Han** **Fig. 5**

**Penicillate cells:** Foots cylindrical, irregular in width, 20-52×7.5-12.5 (-17.5) μm, not divided in the upper part or divided into 2-4 branchlets, sometimes bifurcate in the middle or lower part; filaments 10-30(-40) μm, generally shorter than the foots, 2-3 μm wide.

**Host:** *Alnus japonica* Steud.

**Materials examined:** SMK 10058 (4 X 1987, Anyang), 10097 (24 X 1987, Suwon), 16898 (30 IX 1999, Seoul), 16926 (4 X 1999, Seoul), 17211 (7 XI 1999, Seoul), 17214 (8 XI 1999, Suwon).

**Note:** The penicillate cells of this species were illustrated by Yu and Lai (1979) without measurements and by Shin (1988) with a short description and measurements. Recently Nomura (1997) described the penicillate cells as 50-90 μm in total length, foots 25-57.5×6-17.5 μm, sometimes divided in the upper part of foots, filaments generally shorter than the foots. These previous records agree with the present observation.

**4.** ***Phyllactinia corni*** **H.D. Shin & Y.J. La** **Figs 1 and 6**

**Penicillate cells:** Foots irregular to short cylindrical, irregular in width, 20-35(-42)×12.5-20 μm, divided into 2-8 branchlets in the upper part, each branchlet short cylindrical to somewhat bulbose; filaments 15-25 μm, generally shorter than the foots, 2-3 μm wide.

**Host:** *Cornus officinalis* Sieb. & Zucc.

**Materials examined:** SMK 10241 (3 X 1989, Kangnung), 10575 (15 X 1990,

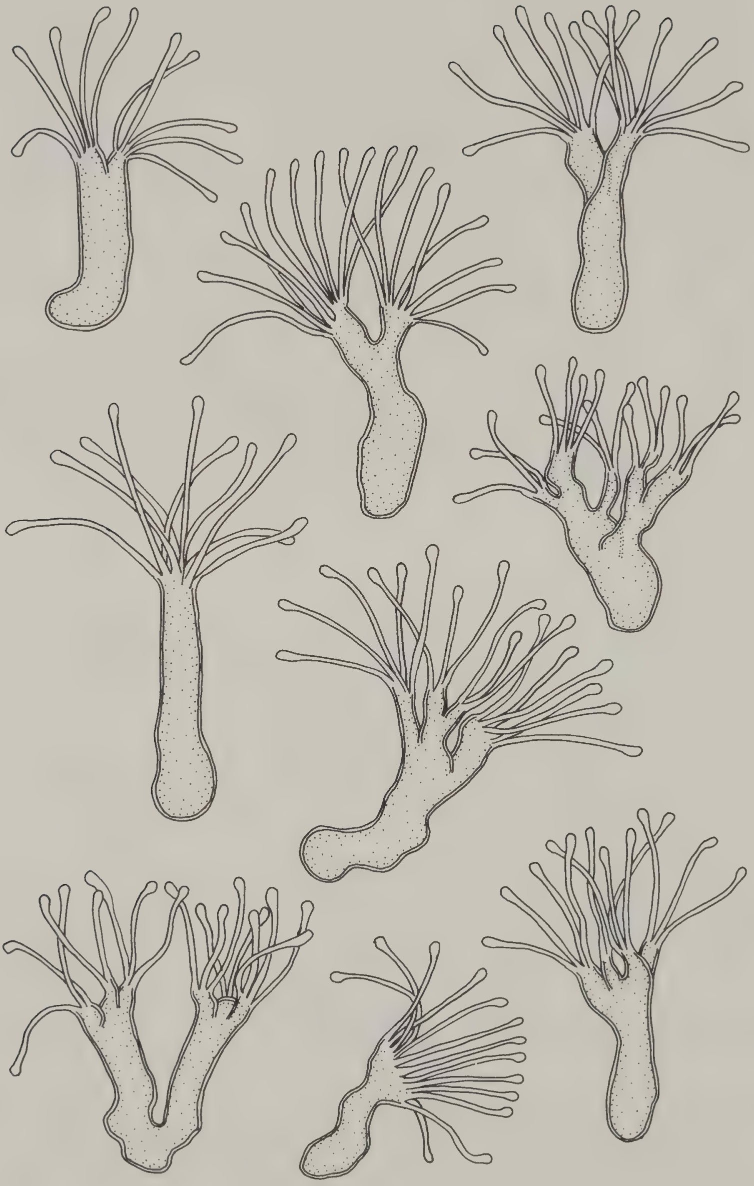

**Fig. 4.** Penicillate cells of *Phyllactinia ailanthi* on *Ailanthus altissima*.

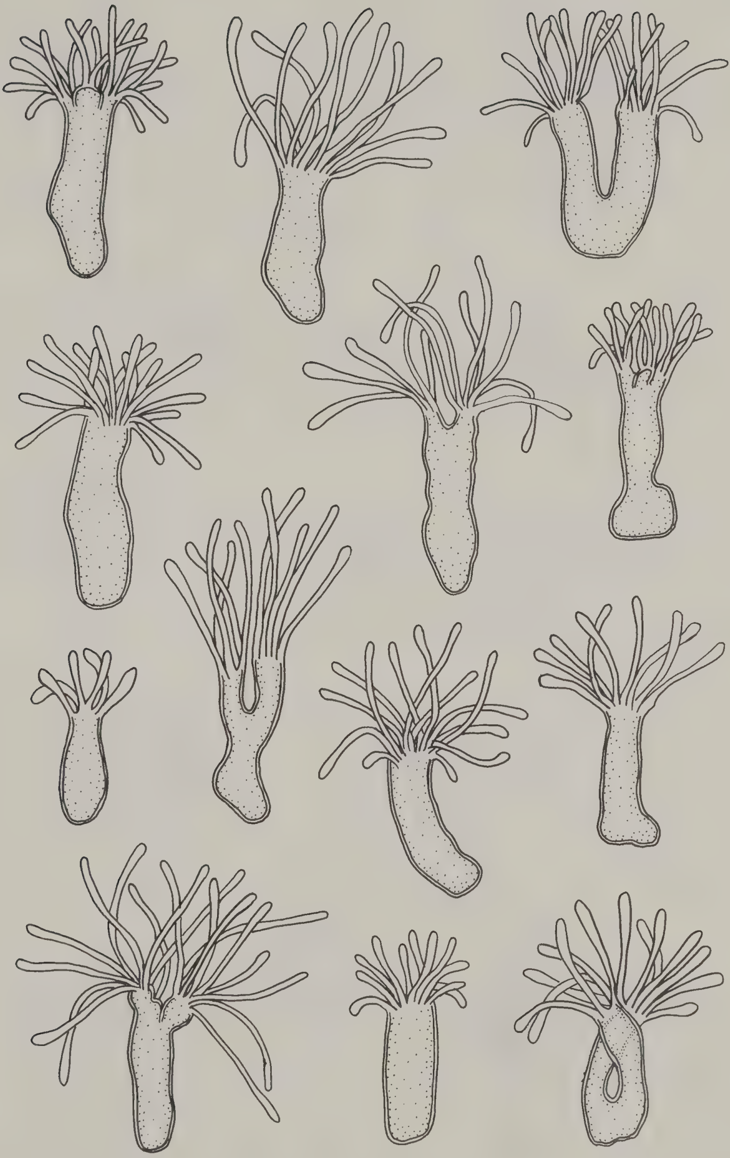

**Fig. 5.** Penicillate cells of *Phyllactinia alni* on *Alnus japonica*.

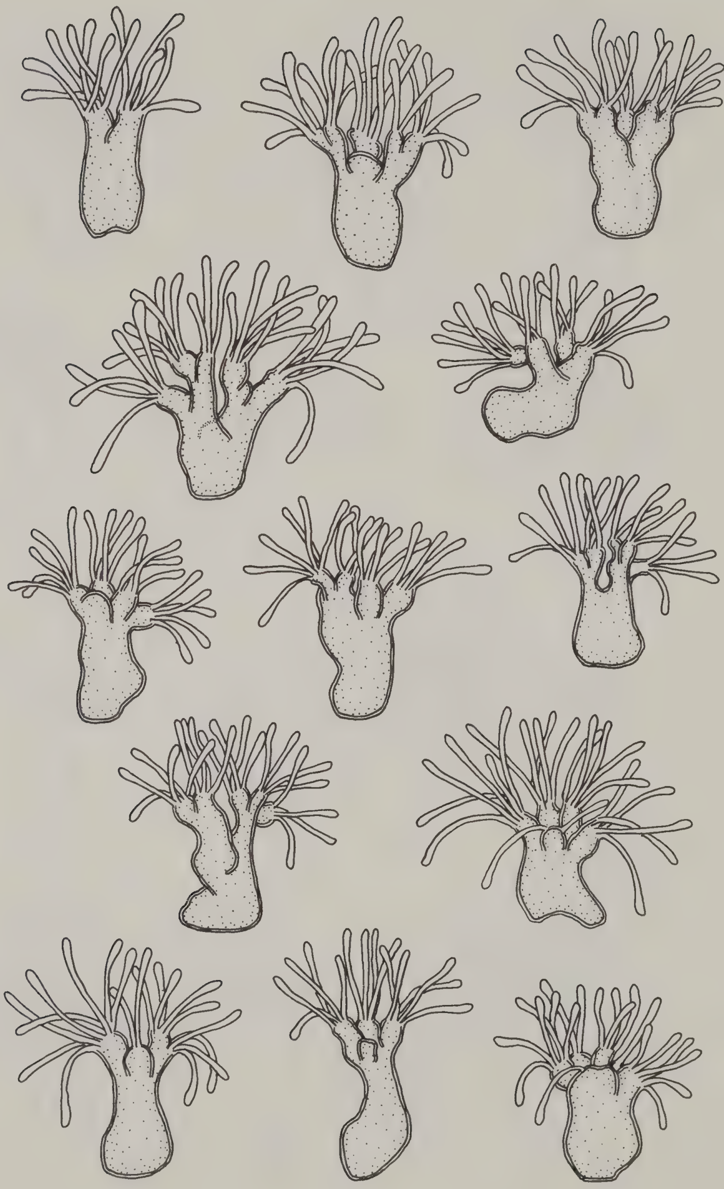

**Fig. 6.** Penicillate cells of *Phyllactinia corni* on *Cornus officinalis*.

Kangnung), 12378 (17 XI 1992, Kangnung), 15383 (8 X 1998, Suwon), 15525 (20 X 1998, Seoul), 15596 (28 X 1998, Namyangju), 16947 (4 X 1999, Suwon), 17056 (13 X 1999, Seoul), 17199 (7 XI 1999, Seoul), 17651 (28 IX 2000, Namyangju), 17965 (29 X 2000, Jinju).

**Note:** The penicillate cells of this species are characterized by having short foots, mostly less than 70 μm, multi-branched upper parts and short filaments. These features are somewhat similar to those of *Phyllactinia fraxini*, but the filaments are generally shorter than those of the latter species. These two species can be clearly differentiated by the number of ascospores per ascus and the morphology of their anamorphs (Shin, 2000).

### 5. *Phyllactinia fraxini* (DC.) Fuss **Fig. 7**

**Penicillate cells:** Foots irregular to short cylindrical, irregular in width, 25-52×10-24 μm, divided into 2-8 branchlets in the upper part, each branchlet short cylindrical to somewhat bulbose; filaments 15-40 μm, somewhat shorter or longer than the foots, 2-3 μm wide.

**Host:** *Fraxinus* spp.

**Materials examined:** on *Fraxinus mandshurica* Rupr., SMK 10065 (7 X 1987, Chunchon), 10643 (26 X 1990, Suwon), 16965 (6 X 1999, Seoul); on *Fraxinus rhynchophylla* Hance, SMK 16744 (17 IX 1999, Wonju); on *Fraxinus americana* L., SOMF 17537; on *Fraxinus excelsior* L., SOMF 13846.

**Note:** According to Nomura (1997), the penicillate cells of this species are 60-110 μm in total length, foots 20-32.5×7.5-17.5 μm, divided into several branchlets in the upper part of foots, and filaments 2-3 times longer than the foots. These characteristics, with the exception of the length of filaments, fit well with the collections examined in this study. Homma (1937) recorded the penicillate cells with foots 28.8-45.6×9.6-13.2 μm, dichotomously branched at the apical portion, filaments 14.4-40.6 μm. Her data and drawings of two penicillate cells do not deviate from the present observation. Zheng and Yu (1987) provided a drawing of a single penicillate cell for this species of Chinese collection, which shows filaments not longer than the foots.

### 6. *Phyllactinia guttata* (Wallr.: Fr.) Lév. **Fig. 8**

**Penicillate cells:** Foots cylindrical, irregular in width, 32-72×7.5-25 μm, divided into 2-10(-16) branchlets in the upper part, each branchlet short, bulbose; filaments 20-42 μm, somewhat shorter than the foots, 2-4 μm wide.

**Host:** *Corylus avelana* L.

**Material examined:** SOMF 13865.

**Note:** The penicillate cells of this species are characterized by having short, bulbose branchlets on the multi-branched upper part of foots. This character was found only in this species among *Phyllactinia* species examined in the present work and so regarded as unique for this fungus.

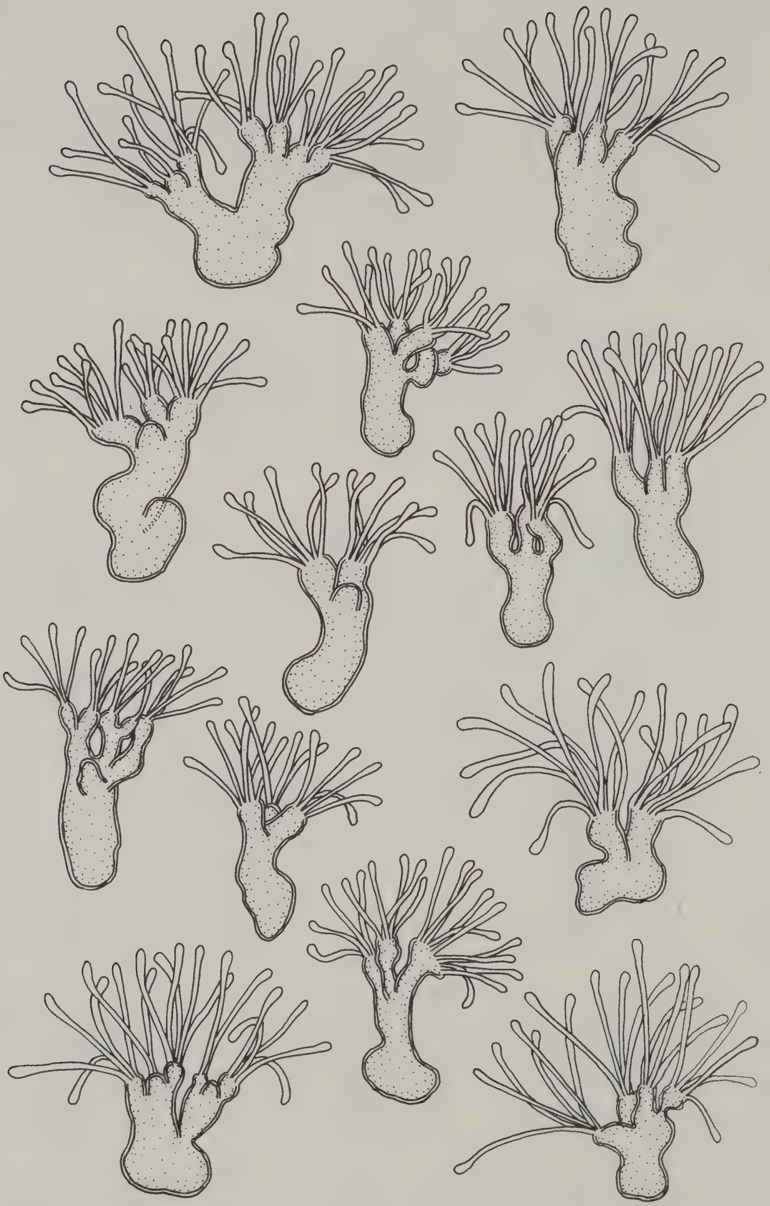

**Fig. 7.** Penicillate cells of *Phyllactinia fraxini* on *Fraxinus mandshurica.*

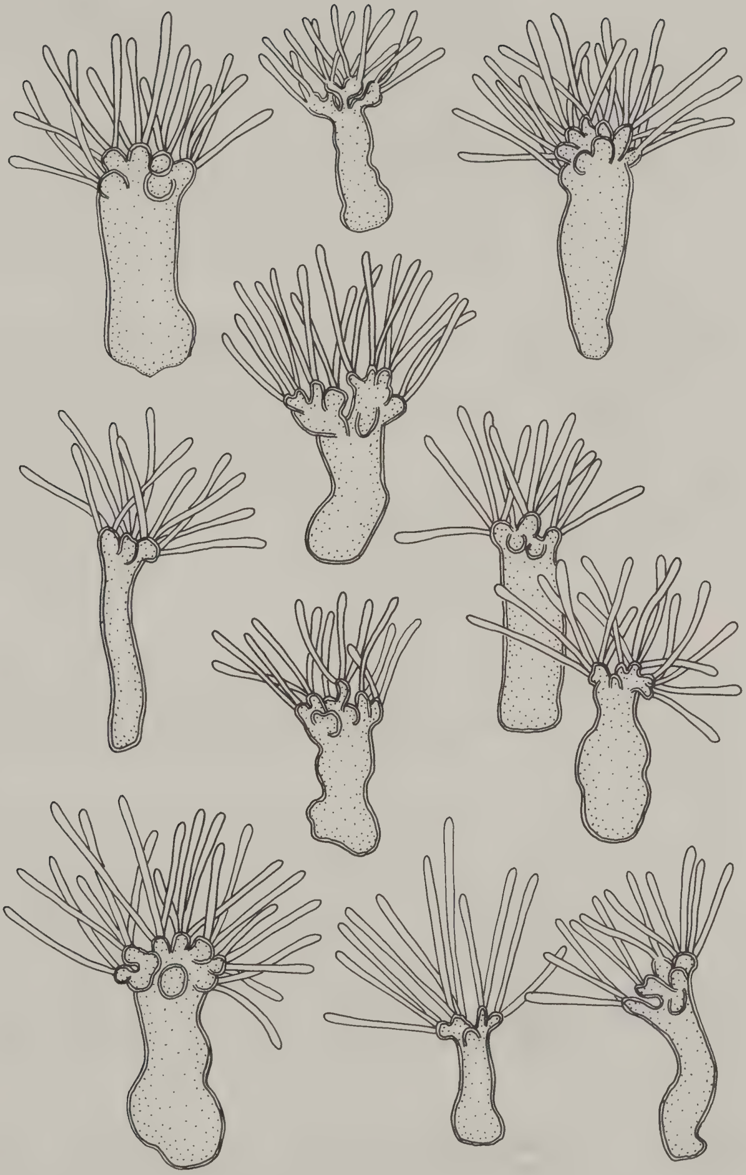

Fig. 8. Penicillate cells of *Phyllactinia guttata* on *Corylus avelana.*

### 7. *Phyllactinia kakicola* Sawada **Fig. 9**

**Penicillate cells:** Foots cylindrical, almost straight to irregular in width, 36-74×10-20 μm, not divided or sometimes bifurcate into 2-4 branchlets in the upper part, each branchlet short cylindrical; filaments 10-30 μm, much shorter than the foots, 2-3 μm wide.

**Host:** *Diospyros* spp.

**Materials examined:** On *Diospyros kaki* Thunb., SMK 10213 (20 IX 1989, Kangnung), 10227 (28 IX 1989, Kangnung), 10576 (15 X 1990, Kangnung), 16859 (28 IX 1999, Kanghwa), 16894 (30 IX 1999, Seoul), 17239 (13 XI 1999, Kangnung); on *Diospyros lotus* L., SMK 11412 (30 X 1991, Kangnung), 11419 (30 X 1991, Kangnung), 12713 (23 X 1993, Kangnung), 17200 (7 XI 1999, Seoul), 17729 (2 X 2000, Samchok).

**Note:** Nomura (1997) briefly described the penicillate cells of this species (foots short, 25-37.5 μm, apically not divided). His description does not agree with the present observation. The authors examined more than 50 specimens from eleven collections listed above and found that all of the penicillate cells of this species have long foots and short filaments as described above. Homma (1937) mentioned that the foots were 40.8-50.4×13.2-16.8 μm and the filaments 21.6-24 μm in length. Similar morphological features of the penicillate cells for this species were provided by Zheng and Yu (1987). The two previous descriptions coincide well with the present observation.

### 8. *Phyllactinia mali* (Duby) U. Braun **Fig. 10**

**Penicillate cells:** Foots coral-shaped, irregular in width, 30-64×12-44 μm, divided into 2-12 branchlets in the middle or upper part, each branchlet short cylindrical; filaments 14-32μm, generally shorter than the foots, 2-3 μm wide.

**Host:** *Pyrus* spp.

**Materials examined:** On *Pyrus ussuriensis* var. *macrostipes* (Nakai) T. Lee, SMK 14329 (3 X 1997, Seoul), 14391 (8 X 1997, Namyangju), 16628 (6 IX 1999, Seoul), 17178 (27 X 1999, Seoul), 17227 (8 XI 1999, Seoul), 17840 (12 X 2000, Seoul); on *Pyrus ussuriensis* var. *seoulensis* T. Lee, SMK 16598 (4 IX 1999, Seoul), 16958 (6 X 1999, Seoul), 17228 (8 XI 1999, Seoul), 17837 (12 X 2000, Seoul).

**Note:** The penicillate cells of this species are characterized by having coral-shaped foots with many branchlets. Similar morphological features for this species were described by Homma (1937), Zheng and Yu (1987) and Nomura (1997).

### 9. *Phyllactinia moricola* (Henn.) Homma **Fig. 11**

**Penicillate cells:** Foots irregular to almost cylindrical, irregular in width, 20-52×10-18μm, divided into 2-8 branchlets in the upper part, each branchlet short cylindrical; filaments 20-50(-65) μm, generally longer than the foots, 2-3 μm wide.

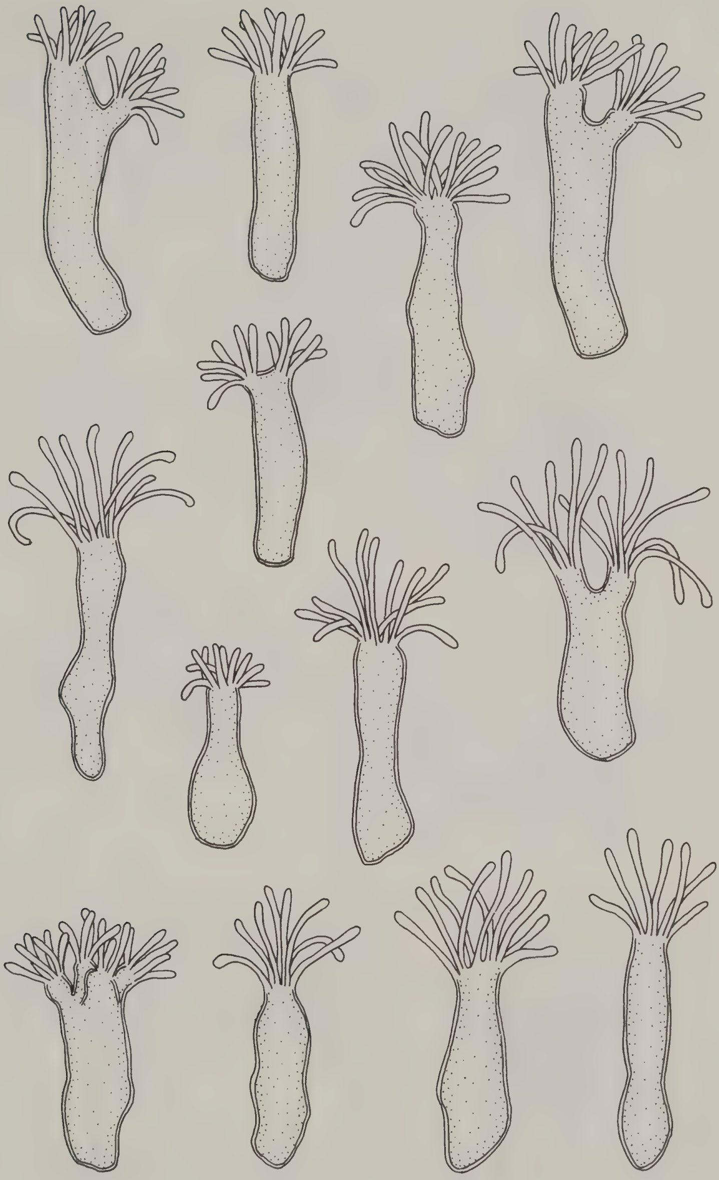

**Fig. 9.** Penicillate cells of *Phyllactinia kakicola* on *Diospyros kaki*.

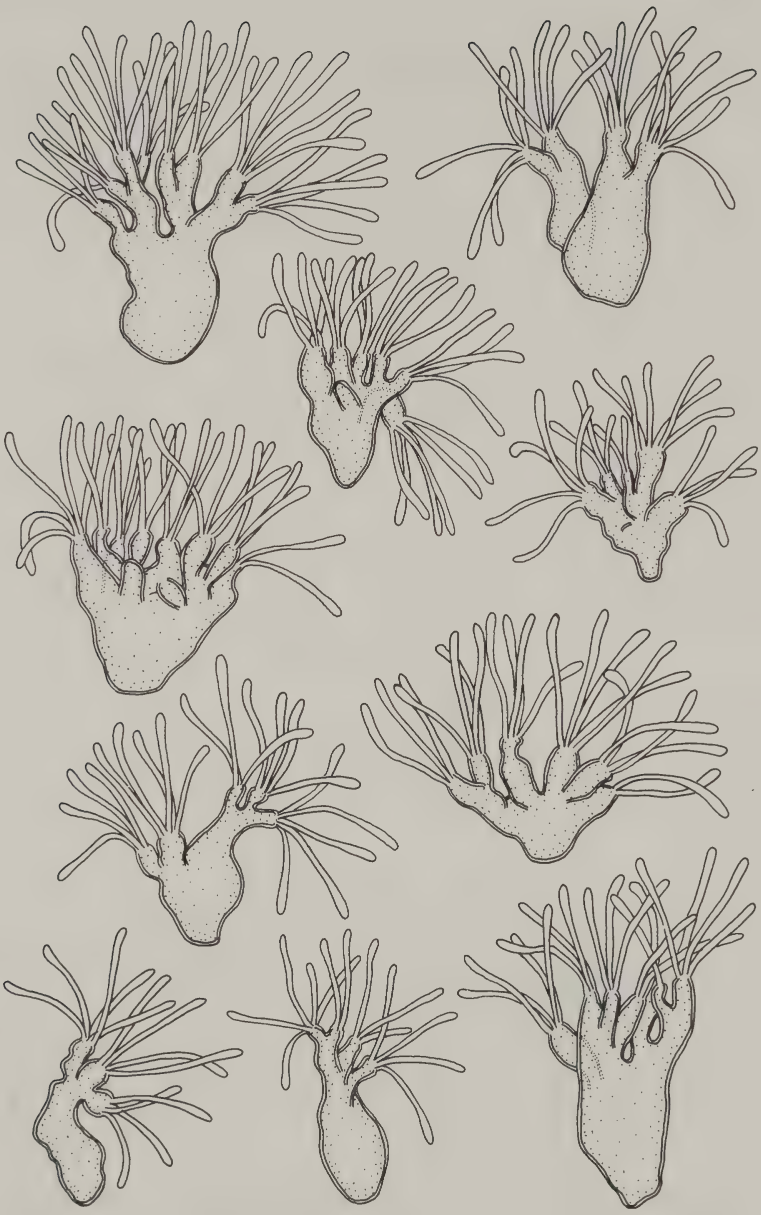

**Fig. 10.** Penicillate cells of *Phyllactinia mali* on *Pyrus ussuriensis* var. *macrostipes*.

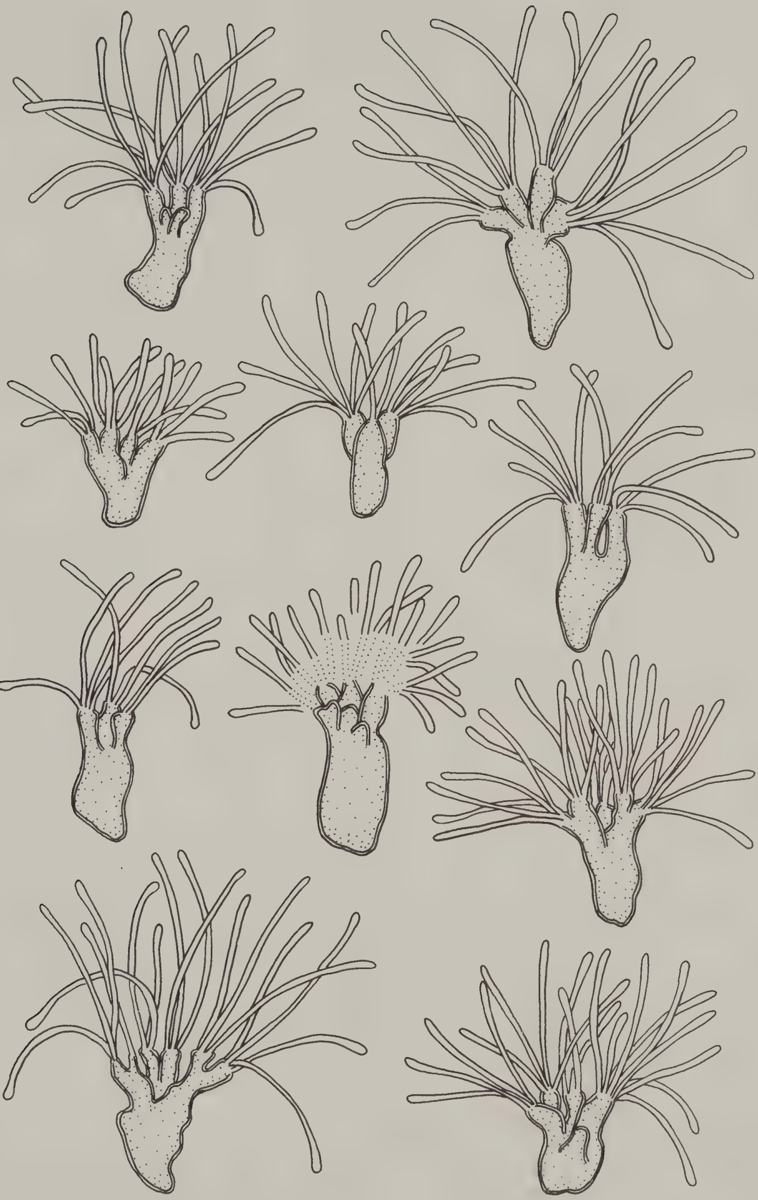

**Fig. 11.** Penicillate cells of *Phyllactinia moricola* on *Morus alba*.

**Host:** *Morus* spp.

**Materials examined:** On *Morus alba* L., SMK 10193 (21 VIII 1989, Kangnung), 10404 (15 IX 1990, Kangnung), 11375 (22 X 1991, Kangnung), 11840 (9 VIII 1992, Kangnung), 12134 (10 X 1992, Kangnung), 12140 (10 X 1992, Kangnung), 12177 (13 X 1992, Kangnung), 12254 (21 X 1992, Kangnung), 12755 (31 X 1993, Kangnung), 13385 (11 XI 1993, Samchok), 13446 (27 XI 1994, Kangnung), 16784 (17 IX 1999, Wonju), 16861 (28 IX 1999, Kanghwa), 16912 (4 X 1999, Suwon), 17197 (3 XI 1999, Suwon), 17203 (7 XI 1999, Seoul), 17215 (8 XI 1999, Suwon), 17952 (29 X 2000, Jinju); on *Morus bombycis* Koidz., SMK 14352 (4 X 1997, Pochon), 16806 (24 IX 1999, Pochon), 17230 (8 XI 1999, Seoul), 18145 (21 XI 2000, Cheju).

**Note:** Nomura (1997) described penicillate cells of 52.5-67.5 μm in length and foots 17.5-32.5×12-20 μm for this species based on Japanese collections. His drawing of this structure is quite similar to the present observation. Takamatsu *et al.* (1982) gave scanning electron micrographs of penicillate cells for this species with several branchlets in the upper part.

### 10. *Phyllactinia rhododendri* H.D. Shin & Y.J. La **Fig. 12**

**Penicillate cells:** Foots cylindrical, almost straight to irregular in width, 32-54×6-20 μm, not divided or occasionally bifurcate into 2 branchlets in the upper part, each branchlet short cylindrical; filaments 20-34 μm, generally shorter than the foots, 2-3 μm wide.

**Host:** *Rhododendron* spp.

**Materials examined:** On *Rhododendron mucronulatum* Turcz., SMK 10077 (10 X 1987, Suwon), 10201 (8 IX 1989, Kangnung), 10220 (22 IX 1989, Kangnung), 10228 (28 IX 1989, Kangnung), 10695 (13 XI 1990, Kangnung), 11313 (15 X 1991, Kangnung), 11373 (22 X 1991, Kangnung), 12025 (30 IX 1992, Kangnung), 13251 (27 X 1994, Kangnung), 13384 (11 XI 1994, Samchok), 15572 (27 X 1998, Seoul), 16600 (4 IX 1999, Seoul), 16882 (30 IX 1999, Seoul), 16917 (4 X 1999, Suwon), 16974 (8 X 1999, Anyang), 17198 (7 XI 1999, Seoul), 17919 (17 X 2000, Kangnung); on *Rhododendron schlippenbachii* Max., SMK 11374 (22 X 1991, Kangnung), 13186 (18 X 1994, Kangnung), 16595 (4 IX 1999, Seoul), 16883 (30 IX 1999, Seoul), 16985 (8 X 1999, Anyang), 17204 (7 XI 1999, Seoul), 17219 (8 XI 1999, Suwon).

**Note:** The penicillate cells of this species are characterized by narrow, long foots and relatively short filaments. These characters are similar to those of *Phyllactinia kakicola*.

### 11. *Phyllactinia salmonii* S. Blumer **Fig. 13**

**Penicillate cells:** Foots long, cylindrical, almost straight to irregular in width, 36-86×7.5-24 μm, not divided or divided into 2(-4) branchlets in the upper part, each branchlet short cylindrical; filaments 16-40 μm, shorter than the foots, 2-3 μm wide.

**Host:** *Paulownia* spp.

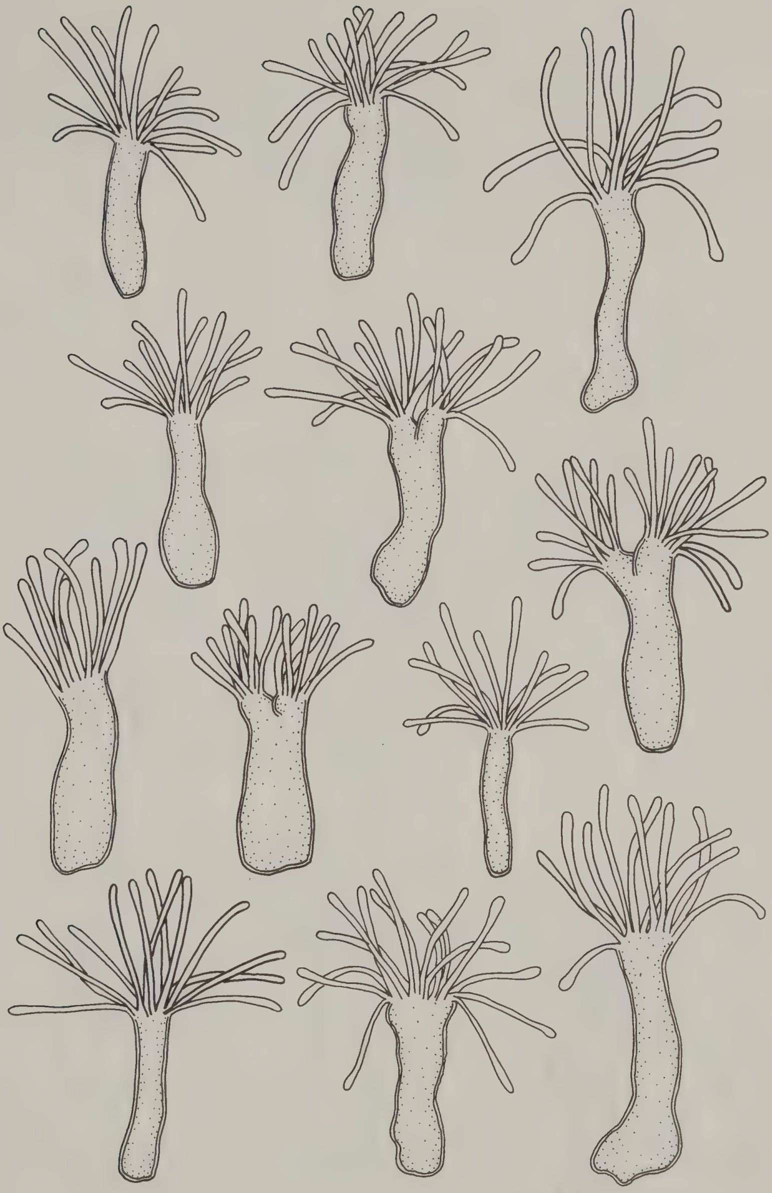

**Fig. 12.** Penicillate cells of *Phyllactinia rhododendri* on *Rhododendron mucronulatum*.

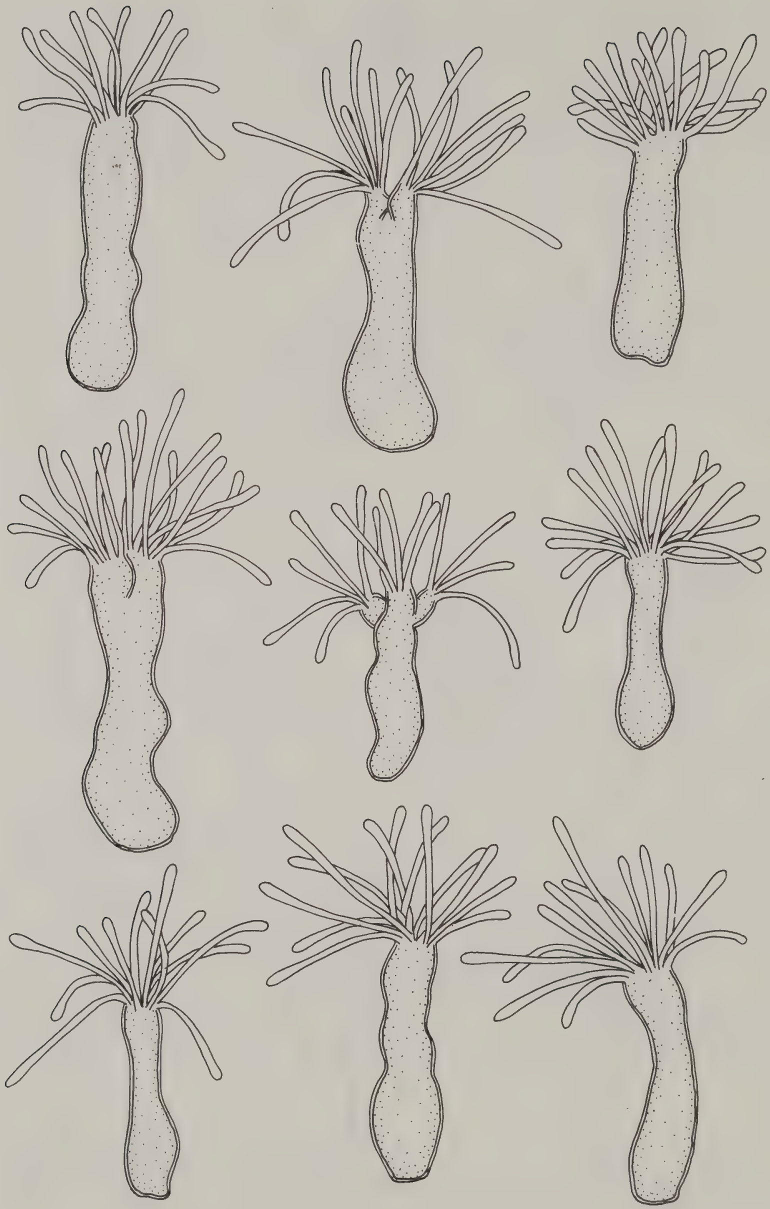

**Fig. 13.** Penicillate cells of *Phyllactinia salmonii* on *Paulownia tomentosa*.

**Materials examined:** On *Paulownia coreana* Uyeki, SMK 12084 (7 X 1992, Kangnung), 16591 (4 IX 1999, Seoul), 16616 (4 IX 1999, Seoul), 16804 (19 IX 1999, Seoul); on *Paulownia tomentosa* (Thunb.) Steud., SMK 17202 (7 XI 1999, Seoul), 17226 (8 XI 1999, Seoul), 17229 (8 XI 1999, Seoul), 18062 (6 XI 2000, Seoul).

**Note:** The penicillate cells of this species are characterized by long, cylindrical foots and short filaments. Drawings and descriptions of penicillate cells provided for this species by Homma (1937), Zheng and Yu (1987) and Nomura (1997) are close to the present observation.

### 12. *Phyllactinia* sp. on *Betula* **Fig. 14**

**Penicillate cells:** Foots cylindrical, irregular in width, 20-44×7.5-15 µm, not divided or divided into 2-4 branchlets in the upper part, each branchlet short cylindrical; filaments 20-50(-65) µm, generally longer than the foots, 2-3 µm wide.

**Host:** *Betula platyphylla* var. *japonica* Hara

**Materials examined:** SMK 15470 (12 X 1998, Seoul), 15589 (27 X 1998, Seoul), 16897 (30 IX 1999, Seoul), 17231 (8 XI 1999, Seoul), 18052 (6 XI 2000, Seoul).

**Note:** The *Phyllactinia* sp. on *Betula* spp. has been recorded as *P. guttata* sensu lat. (Braun, 1987), *P. alni* (Yu and Han, 1979; Zheng and Yu, 1987) or *P. betulae* (see Braun, 1987). Shin (unpublished data, 2000) compared anamorphic characteristics of *Phyllactinia* on *Alnus* and *Betula*, and found that they agree by having curved foot-cells of the conidiophores and other features. The present observations on penicillate cells in *Phyllactinia* on *Betula* are also in good agreement with those on *Alnus*, although the filaments are shorter than in the latter host.

### 13. *Phyllactinia* sp. on *Hemiptelea* **Fig. 15**

**Penicillate cells:** Foots irregular to cylindrical, irregular in width, 25-56×7.5-18 µm, divided into 4-12 branchlets in the upper part, each branchlet short cylindrical to somewhat bulbose; filaments 12-30 µm, generally shorter than the foots, 2-3 µm wide.

**Host:** *Hemiptelea davidii* Planch.

**Materials examined:** SMK 15648 (4 XI 1998, Pochon), 17191 (27 X 1999, Pochon).

**Note:** The identity of *Phyllactinia* sp. on *Hemiptelea* is uncertain. The penicillate cells of this material are characterized by short length, multi-branched upper parts, and short filaments. These characters are similar to those of *Phyllactinia corni*.

### 14. *Phyllactinia* sp. on *Juglans* **Figs 2 and 16**

**Penicillate cells:** Foots long, cylindrical, almost straight or irregular in width, 42-106×7.5-20 µm, bifurcate or divided into 2-4(-6) branchlets in the

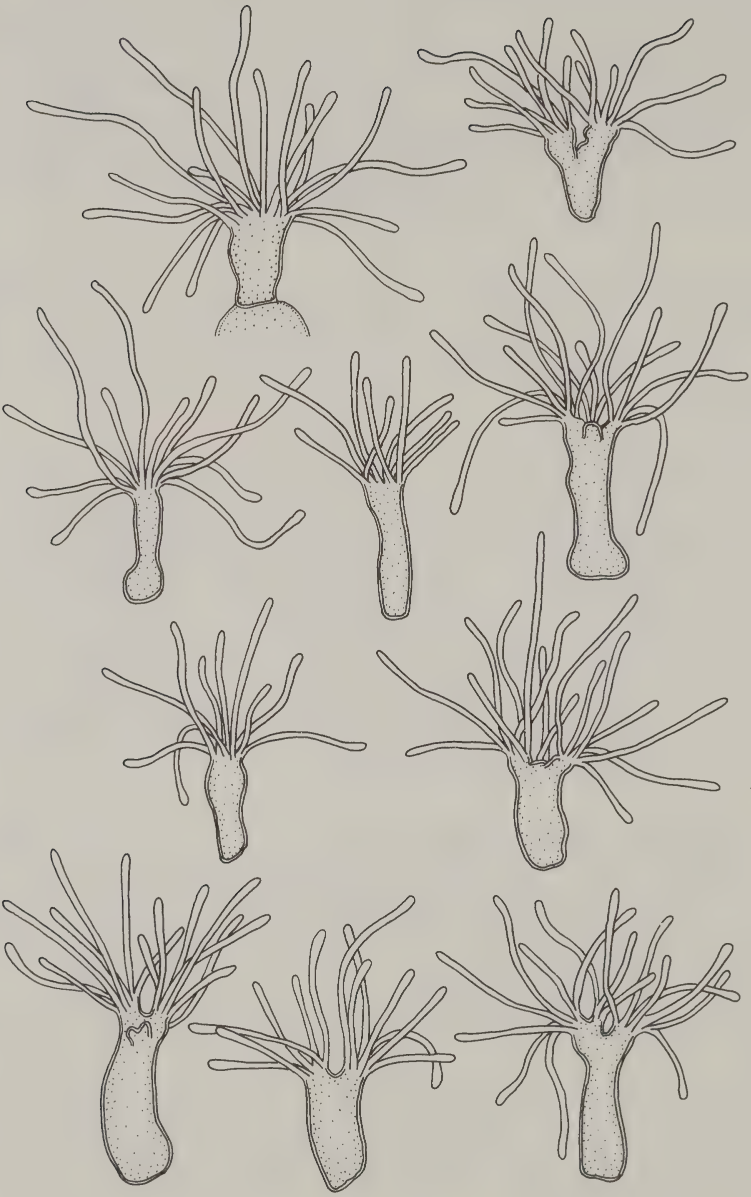

**Fig. 14.** Penicillate cells of *Phyllactinia* sp. on *Betula platyphylla* var. *japonica*.

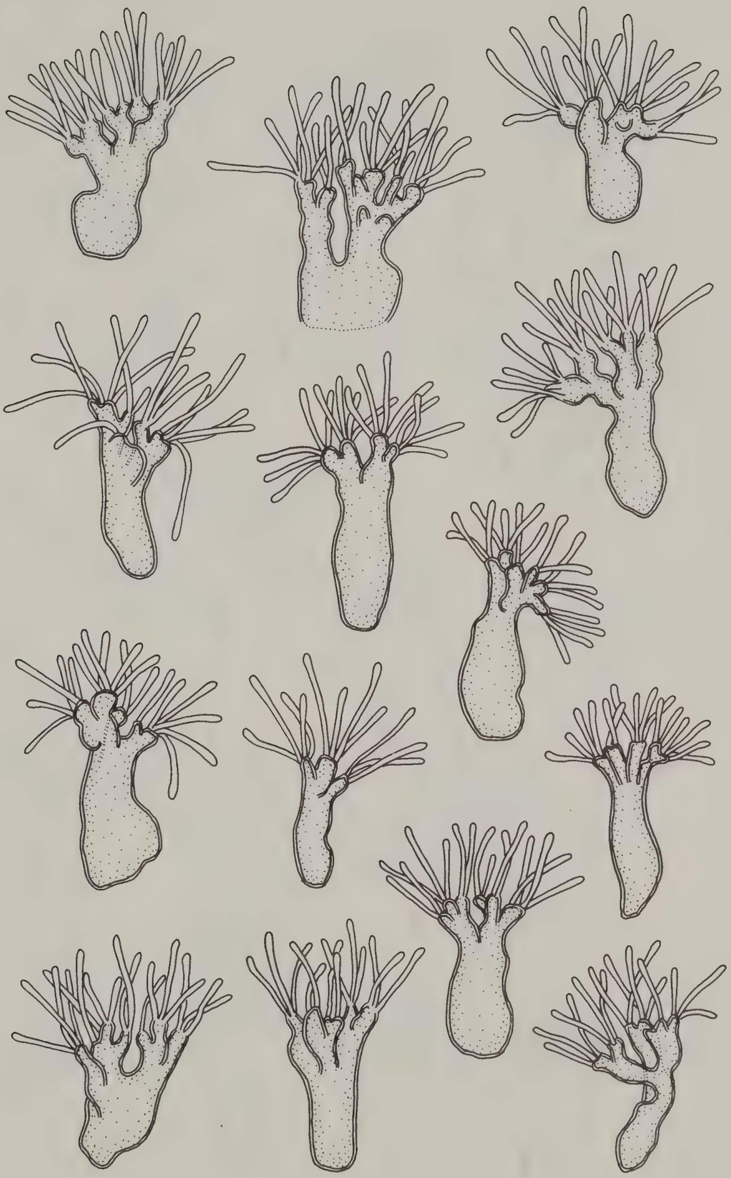

**Fig. 15.** Penicillate cells of *Phyllactinia* sp. on *Hemiptelea davidii*.

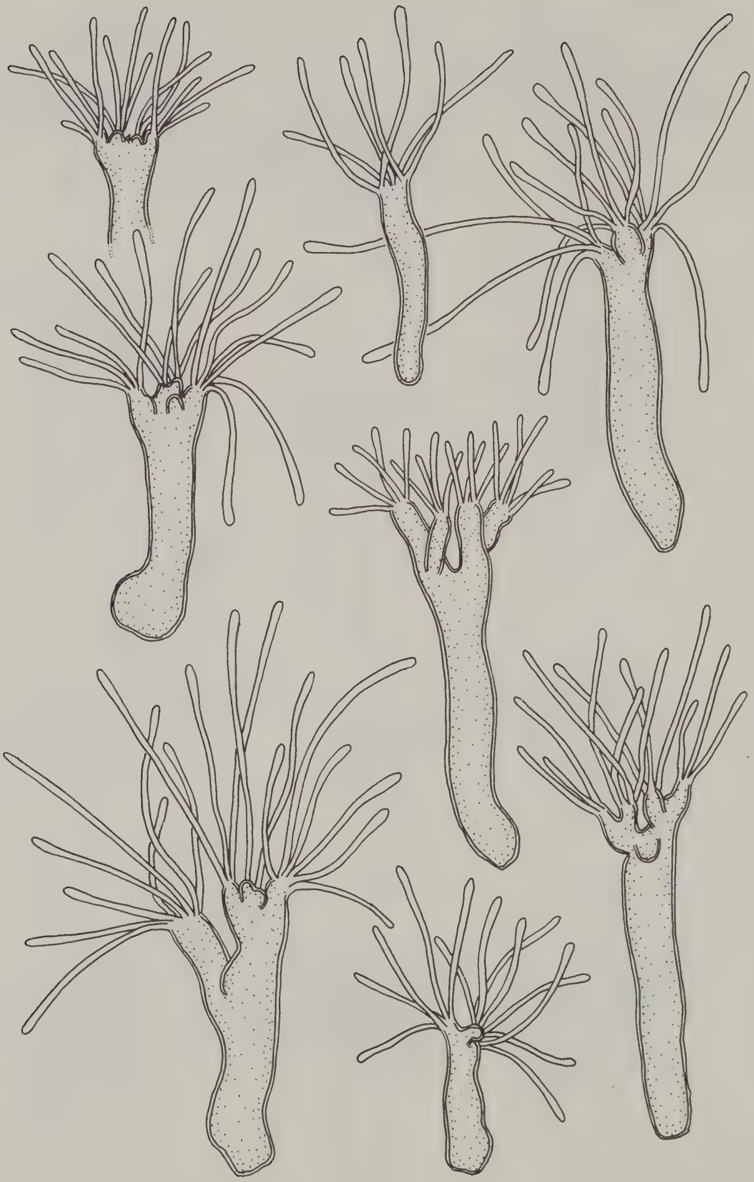

**Fig. 16.** Penicillate cells of *Phyllactinia* sp. on *Juglans mandshurica*.

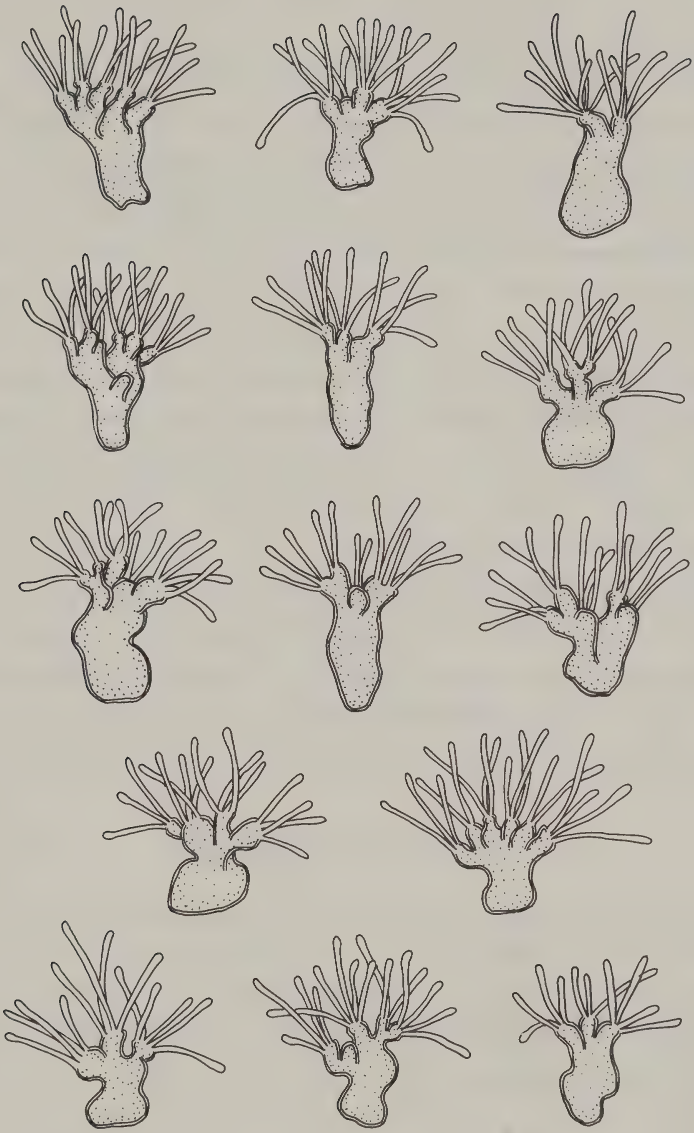

**Fig. 17.** Penicillate cells of *Phyllactinia* sp. on *Philadelphus schrenckii.*

upper part or not divided, each branchlet short cylindrical or somewhat bulbose; filaments 20-80 µm, generally shorter than the foots, 2-3(-4) µm wide.

**Host:** *Juglans mandshurica* Max.

**Material examined:** SMK 17011 (8 X 1999, Anyang).

**Note:** The *Phyllactinia* sp. on *Juglans* had been included in *P. guttata* sensu lat. (Braun, 1987), but recently Chinese authors treated it as *P. juglandis* J.F. Tao & J.Z. Qin with short appendages or *P. juglans-mandshuricae* Y.N. Yu with long appendages (Zheng and Yu, 1987). Though the Korean collection was close to *P. juglandis*, it seems too early to treat it as a separate species. The penicillate cells of this material are characterized by very long, cylindrical foots.

### 15. *Phyllactinia* sp. on *Philadelphus* **Fig. 17**

**Penicillate cells:** Foots irregularly short cylindrical to coral-shaped, irregular in width, 16-40×10-22 µm, divided into 2-10 branchlets in the upper part or from the lower half, each branchlet short cylindrical to somewhat bulbose; filaments 12-34 µm, more or less similar in length to the foots, 2-3 µm wide.

**Host:** *Philadelphus schrenckii* Rupr.

**Materials examined:**SMK 17238 (10 XI 1999, Suwon), 17778 (8 X 2000, Suwon).

**Note:** The *Phyllactinia* sp. on *Philadelphus* was included in *P. guttata* sensu lat. (Braun, 1987). The anamorphic and teleomorphic characteristics of *Phyllactinia* sp. on this host plant seem to be different from the known species of this genus (unpublished data, Shin, 2000). The penicillate cells of this species are characterized by short length, multi-branched upper parts and short filaments. These characters are similar to those of *Phyllactinia corni*.

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# STOMIOPELTOPSIS NOLINAE AND ITS SYNANAMORPH PARVOSYMPODIUM NOLINAE FROM LEAVES OF NOLINA (AGAVACEAE)

Annette W. Ramaley
7 Animas Place
Durango, CO 81301

**Abstract:** *Stomiopeltopsis nolinae* sp. nov. is described. Two synanamorphs are also described. *Parvosympodium nolinae* gen. et sp. nov. is a hyphomycete formed in nature and culture. A pycnothyrial synanamorph was found associated with the ascomata in some collections.

## INTRODUCTION

*Nolina micrantha* I.M. Johnst. (Agavaceae), occurs on rocky slopes or open sandy soil in arid regions of western Texas and eastern New Mexico. This perennial plant consists of a woody, cylindric stem which may be subterranean or form a distinct trunk, and numerous crowded, narrowly linear, evergreen leaves. The leaves remain attached to the stem during decomposition which may take several years. Dead leaves were collected in the Valley of Fires, a volcanic deposit in New Mexico. Near the base of a few leaves were found ascomata of *Stomiopeltopsis* Bat. & Cavalc., Micropeltidaceae Clem. & Shear. This family consists of several genera comprising ascomycetes with superficial, strongly flattened ascomata, round in outline, fissitunicate asci arranged in a ring around the central ostiole, and cellular pseudoparaphyses.

The genus *Stomiopeltopsis*, not previously reported from North America, consists of a single species, *S. linacearum* Bat. & Cavalc. *Stomiopeltopsis nolinae* is described as the second species of this genus. It has larger asci and ascospores, the peridial cells are less meandering than illustrated for *S. linacearum,* and *S. nolinae* lacks the densely reticulate olivaceous mycelium described for *S. linacearum.* In addition, *S. nolinae* occurs on dead leaves of a monocotyledonous plant from an arid habitat. In contrast, *S. linacearum* was collected on living leaves of a dicotyledonous plant in the Amazon.

We know little about the life history of the Micropeltidaceae. Several pycnothyrial genera have been associated with members of the family, but few were identified as their anamorphs. *Myxothryiopsis* Bat. & A.F. Vital (as *Plenotrichella* Bat. & A.F. Vital) was named as an anamorph of *Chaetothyrina* Theiss. (as *Setopeltis* Bat. & A.F. Vital) (Batista 1959). *Sirothyriella* Höhn. was identified as the conidial state of *Stomiopeltis pinastri* (Fckl.) von Arx (Ellis 1977). *Sirothyrium citri* Bitancourt was recognized as an anamorph of *Stomiopeltis citri* Bitancourt based on their association, hyphal connection, and structural similarities of the ascomata and conidiomata (Bitancourt 1934). *Stomiopeltopsis linacearum* was associated with *Plenotrichaius* Bat. & Valle, *Plectopeltis* Syd., and *Peltaster* Syd. & P. Syd. (Batista & Cavalcanti 1963). The distinct ostiole of *Plenotrichaius*, flabellate conidiophores of *Plectopeltis*, and subiculum of *Peltaster* distinguish these genera from the pycnothyrial form with hyphal connections to *Stomiopeltopsis nolinae* ascomata. This form is therefore described as a synanamorph of *Stomiopeltopsis nolinae*.

*Atichia* Flot., a hyphomycete associated with *Mendoziopeltis* Bat. (Batista 1959), has staurosporous, solitary conidia. The hyphomycete occasionally found with *Stomiopeltopsis nolinae* ascomata has falcate, septate, hyaline conidia born on lageniform conidiogenous cells with a rachiform sympodial axis. A new genus is proposed to accommodate this fungus because its features could not be found in any other hyphomycete genus.

## MATERIALS AND METHODS

Ascomata were removed from the leaves, rinsed twice in sterile tap water, transferred to a third drop of sterile tap water, and cut open. The peridium was removed and the ascomatal contents were separated into pieces containing asci, ascospores, and hamathecial filaments. Pieces were transferred to potato dextrose agar (PDA, BBL) in Petri plates and the droplet with each piece was spread with a sterile needle. Germlings from propagules within the area where a droplet had been spread were isolated onto PDA. Cultures were maintained on tubes of PDA at room temperature in daylight. Most components were measured using an ocular micrometer having 0.8 $\mu$m increments; ascomata were measured using an ocular micrometer with 24 $\mu$m increments. Conidia were measured in a straight line from apex to base so the extra length afforded by their curvature is not included. Drawings are from photographs of material on slides prepared with lactophenol.

## TAXONOMY

**Stomiopeltopsis nolinae** A.W. Ramaley *sp. nov.* FIGS. 1–4

*Ascomata scutata, circularia, 125–225 μm diam., unilocularia, plerumque separata, brunnea. Supra peridium ex 1 vel 2 stratis cellularum brunnearum plus minusve flexuosarum, interdum intra aliquot stratis hyalinis constans; stratum basale tenue, ex textura epidermoidea constans, cellulae hyalinae vel subbrunneae, hyphis tenuibus (<1.0 μm) epidermidem hospitis penetrantibus. Asci bitunnicati, oblongi ad ventricosos, 36.0–51.2 (–60.0) × 8.0–12.0 (–13.6) μm, octospori. Physes hamathecii septata, ramosa, ca 1.0 μm diam. Ascosporae clavatae 13.6–22.4 × 3.2–4.0 μm, (1–) 2 (–3)-septatae, hyalinae, leves, tenuiparietibus.*

Anamorph: *Parvosympodium nolinae* A.W. Ramaley

HOLOTYPE: U.S.A. NEW MEXICO: Lincoln County, Valley of Fires, roadside plants. On dead leaves of *Nolina micrantha* I.M. Johnst. 28 Oct. 1998, A.W. Ramaley 9815B (UC1726837))

*Ascomata* scutate, circular, 125–225 μm diam, unilocular, usually separate, occasionally confluent but each with its own ostiole, brown. Upper peridium of 1 or 2 layers of brown, more or less meandering cells, sometimes a few hyaline layers at the interior, thin lower wall consisting of *textura epidermoidea*, cells hyaline to pale brown, with thin (< 1 μm) hyphae penetrating the host epidermis. Pale brown reticulum connecting spore-producing structures. *Asci* bitunicate, oblong to somewhat ventricose, 36.0–51.2 (–60.0) × 8.0–12.0 (–13.6) μm, 8-spored. Hamathecium filamentous, septate, much-branched, ca 1.0 μm diam. *Ascospores* clavate, 13.6–22.4 × 3.2–4.0 μm, (1–) 2 (–3)-septate, hyaline, smooth, thin-walled.

The first septum in an ascospore is below the midpoint, the second septum usually divides the ascospore approximately into thirds If a third septum is formed, it is usually median in position but may appear in the bottom cell of the ascospore.

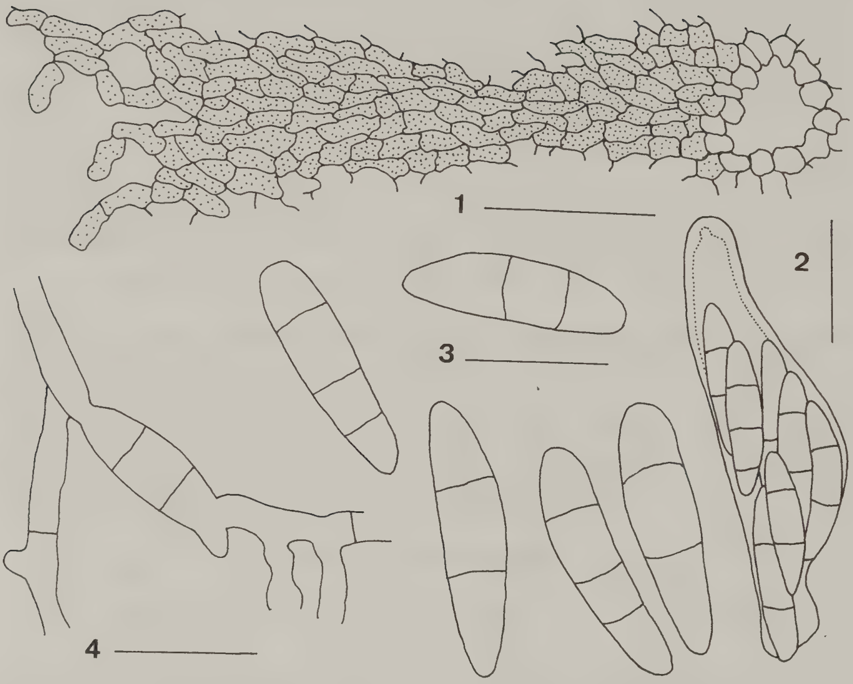
**Parvosympodium** A.W. Ramaley *gen. nov.*

*Mycelium parcum, hyphae hyalinae vel brunneae perpallidae, ramosae. Conidiogenesis holoblastica, sympodialis. Cellulae conidiogenae plerumque lageniformes, plerumque discretae, hyalinae, leves, axis conidiogena rachiformis. Conidia septata, hyalina, levia.*

*Sp. typ: Parovsympodium nolinae* A.W. Ramaley

**Parvosympodium nolinae** A.W. Ramaley *sp. nov.* FIGS. 5–8

*Ex natura, mycelium plerumque prope fissuram ubi stomata locata, rare hypha conidia ferrentes in epidermide exposita. Conidiogenesis holoblastica, sympodialis. Cellulae conidiogenae*



FIGS. 1–4. *Stomiopeltopsis nolinae.* 1. Surface view of part of an ascoma. 2. Ascus. 3. Ascospores. 4. Germinating ascospore. Scale bars: 1 = 25 $\mu$m; 2–4 = 9 $\mu$m.

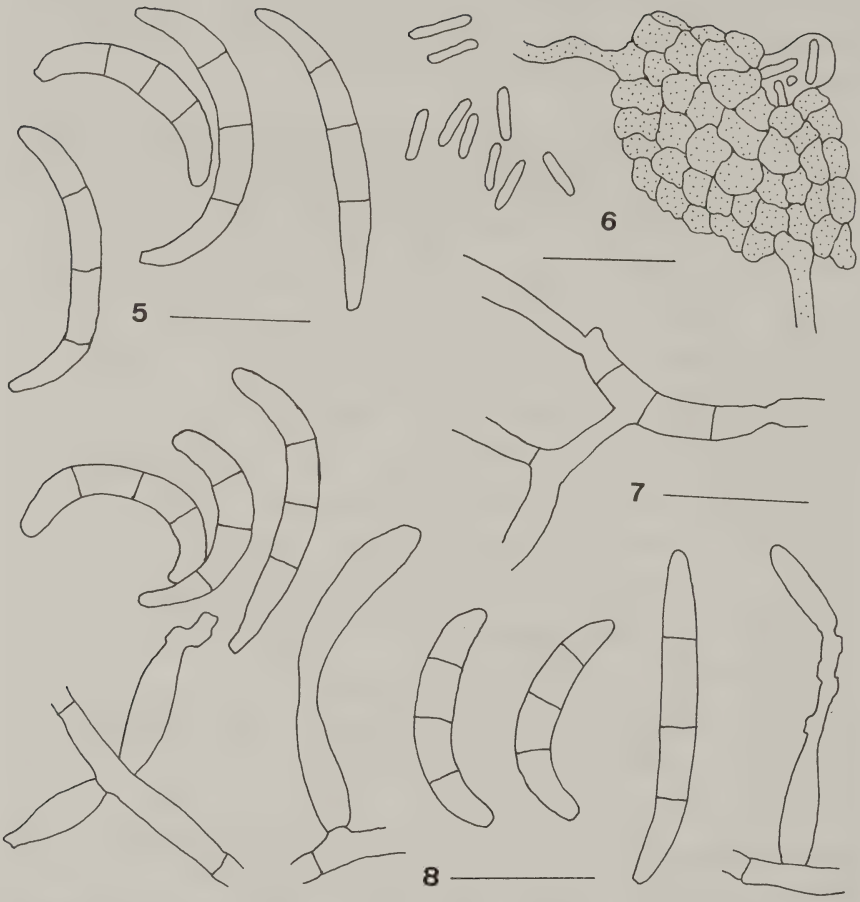
*lageniformes, fortasse plus quam unus in cellula hyphae, axis conidiogena rachiformis. Conidia falcata, interdum leviter curvata, extremis ambobus leniter attenuatis, apex rotundatus, basis plerumque aliquantum truncata, 12.8–25.6 × 2.0 (–2.4) µm, 3-septata, septum primum medium, hyalina, levia.*

HOLOTYPE: U.S.A. NEW MEXICO: Lincoln County, Valley of Fires, roadside plants. In dead leaves of *Nolina micrantha* I.M. Johnst. 28 Oct. 1998, A.W. Ramaley 9815B (UC1726837, dried agar culture deposited UC1726841)

*Mycelium* scanty, hyphae hyaline to very pale brown, branched, usually found near the stomatal cleft, only occasional hyphae bearing conidia found on exposed epidermis. *Conidiogenesis* holoblastic, sympodial. *Conidiogenous* *cells* mostly lageniform, mostly discrete, hyaline, smooth, more than one conidiogenous cell may be on a hyphal cell, conidiogenous axis rachiform, conidia produced successively at the narrow elongating tip of a conidiogenous cell. *Conidia* falcate, occasionally only slightly curved, gently tapering at each end, apically rounded, basally somewhat truncate, 12.8–25.6 × 2.0 (–2.4) $\mu$m, 3-septate, first septum median, hyaline, smooth.

*Parvosympodium* could not be placed reasonably in any existing genus among hyphomycetes with conidiogenous cells having a rachiform conidiogenous axis and phragmosporous conidia. *Drechslerella* Subram., *Gangliophragma* Subram., *Dactylella* Grove, *Arnoldiomyces* Morgan-Jones, *Pleurothecium* Höhn., *Pseudohansfordia* G.R.W. Arnold, *Spiropes* Cif., and *Chionomyces* Deighton & Piroz. have upright conidiophores. Conidiogenous cells may become integrated in *Spiropes, Dactylella, Pseudohansfordia, Chionomyces,* and *Gangliophragma.* In addition, *Gangliophragma*, *Dactylella,* and *Drechslerella* are found on nematodes, and *Arnoldiomyces, Chionomyces, Pseudohansfordia,* and *Spiropes* are from fungi. *Pleurothecium* may have curved to falcate, hyaline, 3-septate conidia, but these are born on attenuated denticles on the upright, brown, conidiophores. *Mycocentrospora* Deighton is aquatic, has appendaged or attenuated, multiseptate, partially pigmented conidia, and sporodochial conidiomata. *Parvosympodium* may most closely resemble *Cylindrosympodium variabile* (de Hoog) Kendrick & Castañda. The septate, hyaline, conidia are scarcely wider than the hyphae, and as in *Parvosympodium*, *Cylindrosympodium* conidiogenous cells are often reduced to conidiogenous cells which are usually terminal. However, *Cylindrosympodium* conidiogenous cells are occasionally intercalary, are geniculate or curved rather than lageniform, and the conidiogenous rachis has crowded, long, flat-topped denticles rather than the low profile of the flattened conidiogenous loci found in *Parvosympodium.*

**Cultural characteristics:** Colonies slow growing, attaining only ca. 2.5 mm diam after 2 weeks in daylight illumination at room temperature. Mycelium ca 1.6 $\mu$m diam, quite compact, hyphae septate, branched, sordid at the agar surface and somewhat below, becoming very dark in age, aerial hyphae white, septate, branched, remaining white to pale brown in age. Conidiogenesis as on the natural substrate. Conidiogenous cells mostly discrete, up to three born laterally on an aerial hyphal cell, occasionally terminal on a hyphal branch. Conidia with the shape and septation of those from nature, 14.4–26.4 × ca 2.4 $\mu$m. Hyphae below the agar surface may develop conidiogenous cells producing numerous conidia in cultures aged six months or more.



FIGS. 5–8. *Parvosympodium nolinae.* 5. Conidia from nature. 6. Side view of surface of pycnothyrial conidioma with expanded, still intact, central exit channel and conidia. 7. Germinating conidium. 8. Conidia from culture. Scale bars: 5, 7, 8 = 9 $\mu$m.; 6 = 10 $\mu$m.

The coelomycetous synanamorph is scutate, 20–36 $\mu$m diam, circular in outline, brown. Conidiogenesis appears to be phialidic. The bacillar conidia, 2.4–4.0 × ca 0.8 $\mu$m, escape through an apical opening provided by a dome-shaped cell wall that ruptures or is sloughed off, or a somewhat elongate chimney much as is found in *Microthyrium nolinae* A.W. Ramaley (Ramaley 1999).

## DISCUSSION

*Parvosympodium* was the only fungus developing from germlings isolated within the area of the droplets spread from isolated pieces of ascomatal contents. Examination of two–three-day-old germlings showed their propagules of origin had the size, shape, and characteristic septation of *Stomiopeltopsis* ascospores. Similar cultures from conidia in *Parvosympodium* cultures showed germlings originating from propagules whose size, shape, and septation were those of conidia. The presence of fewer septa, the absence of a median septum, lack of significant curvature, and greater diameter of the propagules of origin allow germinating ascospores to be easily distinguished from germinating conidia.

*Parvosympodium* was rarely observed in nature. When seen, it was most often located near the toothed epidermal cells of the stomatal cleft. Hyphae were limited and, unless conidiogenous cells were present, any hyphae spreading to exposed epidermis were indistinguishable from the reticulum connecting young ascomata, a condition consistent with the two phases belonging to a single fungus. In only one preparation, from material collected during a rainy week, hyphae of the reticulum near an ascoma were connected to a few pale brown or hyaline hyphae which bore typical *Parvosympodium* conidiogenous cells and conidia. *Parvosympodium* conidia have never been observed entangled in or originating from the peridium of *Stomiopeltopsis* ascomata.

Ascospores or asci could not be isolated individually, and colonies of *Parvosympodium* never produced ascomata and ascospores, so the identity of this fungus as a synanamorph of *Stomiopeltopsis* is not absolutely certain. However, the consistent isolation of *Parvosympodium* from *Stomiopeltopsis nolinae* ascospores and the fortuitous one-time discovery of the connection of the reticulum surrounding one *Stomiopeltopsis* ascoma to hyphae producing *Parvosympodium* conidia, all favor regarding *Parvosympodium* as a synanamorph. In additional support, *Parvosympodium* is rarely observed, so its conidia are not numerous enough to be probable contaminants carried with ascomatal contents into the droplets spread on agar plates after two rinses of entire ascomata, removal of the peridium in a third drop of water, and isolation of pieces of the ascomatal contents.

## ACKNOWLEDGEMENTS

My thanks to Dr. Martina Reblova for her meticulous review of the manuscript and her many suggestions for improvement which were adopted. I also thank

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# NOTES ON HYPHOMYCETES. LXXXVIII. NEW GENERA IN WHICH TO CLASSIFY ALYSIDIUM RESINAE AND PYCNOSTYSANUS AZALEAE, WITH A CONSIDERATION OF SOROCYBE

E. CHRISTOPHER PARTRIDGE AND GARETH MORGAN-JONES

Department of Entomology and Plant Pathology, College of Agriculture,
Auburn University, Alabama 36849, U.S.A.

## ABSTRACT

The novel generic name *Phaeoblastophora* is established for the anamorph presently best known as *Alysidium resinae* in light of significant differences between it and species classified in *Haplotrichum*, of which *Alysidium* is now considered a synonym. A new combination, *Phaeoblastophora resinae*, is made in accordance with the sanctioning of its basionym by Fries. *Alysidium resinae* var. *microsporum* is accorded species status within the genus as *Phaeoblastophora peckii*. *Sorocybe resinae*, the type species of *Sorocybe*, in both its synnematous and mononematous conidiophore states, is considered and compared. The nomenclatural status of *Pycnostysanus azaleae* is reviewed and the anamorph is transferred to a new genus, *Seifertia*, since it cannot be regarded as being congeneric with *Sorocybe resinae*. The four taxa are redescribed and illustrated.

**KEYWORDS:** *Acladium*, *Phaeoblastophora*, *Seifertia*, generic concepts.

## INTRODUCTION

As discussed in several previous publications (Partridge *et al.*, 2000; 2001a; 2001b; 2001c), a number of species classified at one time or other in the genera *Acladium* Link and *Alysidium* Kunze but which cannot be considered congeneric with *Haplotrichum capitatum* (Link) Link, the type species of *Haplotrichum* Link : Fries, are in need of reclassification. The two aforementioned generic names are now unavailable because of their synonymy with *Haplotrichum*, thus necessitating the removal of such taxa elsewhere. With the decision made by Hughes (1958) to transfer the anamorph presently known as *Alysidium resinae* (Fr.) M.B. Ellis to the genus *Acladium* [as *A. aterrimum* (Ehrenb.) S. Hughes], what are, in essence, phylogenetically disparate entities were classified together. Hughes (1953) had previously proposed and adopted the binomial *Oidium ramosum* (Fuckel) S. Hughes [≡ *Torula ramosa* Fuckel, a later synonym of *Racodium aterrimum* Ehrenb., the basionym of *A. aterrimum*] for the same fungus, despite recognizing that its dematiaceous nature, to quote, 'does not really fit the fungus for adequate inclusion in the genus *Oidium*'. Interestingly, in qualifying the preferred placement of this anamorph in *Oidium* Link [typified by *O. aureum* (Pers.) Link, a name misapplied by Link (1809) to what is now known as *Haplotrichum dubium* (Pers.) W.A. Baker & Partridge (see Partridge *et al.*, 2001a)], Hughes (1953) stated that it, together with another unnamed black mold, again to quote, 'may well constitute a new genus'. With the inclusion of this taxon in *Oidium* and subsequently in *Acladium*, both of which accommodated species now classified in *Haplotrichum*, the taxonomic concepts were broadened to the extent of making these respective genera unduly heterogeneous. Likewise, when the anamorph referred to above was classified in *Alysidium* by Ellis (1971) the heterogeneity was perpetuated, and this has been considerably extended in more recent years by the addition of a number of other dematiaceous taxa which are undoubtedly unrelated to species of *Haplotrichum* [see Partridge *et al.*, 2001a]. Now, some fifty years later, what was intimated by Hughes (1953) with regard to the need for a new genus in which to accommodate the dematiaceous taxon under consideration is being brought to fruition by the current authors.

During the course of monographic studies of *Haplotrichum* (Partridge *et al.*, 2001a; 2001b; 2002) it became apparent that not only *Alysidium resinae* but such species as *A. guttulatum* R.F. Castañeda, *A. minus* (R.F. Castañeda) R.F. Castañeda & W.B. Kendr., and *A. pinarense* R.F. Castañeda & W.B. Kendr., required redisposition. *Alysidium minus* was classified in a new genus, *Castanedaea* W.A. Baker & Partridge (Partridge *et al.*, 2001c), while a decision concerning alternative classification of the other taxa remains in abeyance. There can be little doubt, as already alluded to, that these species were not satisfactorily classified in *Alysidium.* Although having certain morphological features, reflecting peculiarities of conidiogenesis, particularly possession of acrogenous chains of holoblastically-produced conidia, in common with *Alysidium fulvum* Kunze, the type species of *Alysidium* [now *Haplotrichum dubium*], they differ in several significant respects. In addition to their dematiaceous nature, and resultant dark, blackish-brown appearance, their colony growth characteristics are quite unlike those typical of *Haplotrichum* species, many of which are known to be mitosporic states of *Botryobasidium* Donk. The latter anamorphs are typified by possession of dense, hypochnoid, subiculum-like, widely-effuse colonies which range in coloration from cream to ochraceous to cinnamon/rufous brown. In the present publication the status of *Alysidium resinae* is considered and a novel generic name is established in which to accommodate it.

The oldest binomial applied to this entity is *Racodium aterrimum* [see Hughes (1958)]. This pre-1821 basionym was not taken up by Ellis (1971), although he was aware of the synonymy, because of the ICBN starting-point provisions existing at the time when the new combination *Alysidium resinae* was made. In light of the changes in the ICBN enacted in 1981, at least in terms of publication date priority, the specific epithet '*aterrimum*' becomes valid. This cannot, however, be taken up because it competes with a name sanctioned by Elias Magnus Fries. Following his description of *Myxotrichum resinae* Fr. : Fr. (Fries, 1832), *Racodium aterrimum* Ehrenb. is cited, with an exclamation mark, as a synonym. In essence, Fries intentionally renamed Ehrenberg's anamorph and although, in usual circumstances, such a new name would be regarded as a superfluous nomenclatural synonym, sanctioning rules dictate that it be accepted. Hence the epithet '*resinae*' rather than '*aterrima*' is perpetuated herein.

Sutton (1973) described *Alysidium resinae* var. *microsporum* B. Sutton, a form having smaller conidia, as the varietal epithet indicates, and appreciably longer conidiophores. This entity also differs from var. *resinae* in certain morphological respects and appears sufficiently distinct to be nomenclaturally elevated and accorded separate species status. Examination of the type specimen of *Torula ramosa* Peck, previously considered to be a synonym of *R. aterrimum* [as *Acladium aterrimum* (Ehrenb.) S. Hughes (see Hughes, 1958)], has indicated that this binomial is based on the same anamorph as is *A. resinae* var. *microsporum* and therefore provides an earlier name for it. This is, however, invalid being a later homonym of *Torula ramosa* Fuckel, a name based on a different nomenclatural type. The binomial *Torula peckii* Sacc. & Syd., established to replace *Torula ramosa* Peck, becomes the earliest available valid binomial applied to this anamorph and is, therefore, taken up as the basionym of a new combination.

An anamorph with which *Alysidium resinae* can be confused is *Sorocybe resinae* (Fr.) Fr., the type species of *Sorocybe* Fr., in its mononematous form, to which the name *Hormodendron resinae* Lindau has been applied. It should be noted that contrary to the comment made by Partridge *et al.* (2001c), the latter binomial cannot be considered a facultative synonym of *Myxotrichum resinae*, since these respective names are based on different entities. In order to more adequately characterize and delineate the differences between these fungi, they are redescribed and illustrated.

The fungus currently known as *Pycnostysanus azaleae* (Peck) E.W. Mason, the causal organism of bud blast and twig blight of rhododendrons, is another somewhat similar species to *Sorocybe resinae.* Although bearing a morphological resemblance, this taxon, however, differs from *S. resinae* to such an extent as to warrant its separate generic classification. Since the generic name *Pycnostysanus* Lindau [type species *P. resinae* Lindau] is based upon the same entity as is *Sorocybe*, the former must be regarded as a synonym of the latter. With regard to *P. azaleae*, given the significant differences between it and *Sorocybe resinae*, its reclassification in a new genus, *Seifertia*, is proposed herein. A treatment of this taxon is included, together with an amplified description of *Sorocybe*.

## TAXONOMIC PART*

***Phaeoblastophora*** Partridge et Morgan-Jones, gen. nov.

Coloniae effusae, nigrae, dispersae, plerumque vel interdum restrictae. Mycelium partim superficiale, partim immersae, ex hyphis ramosis, brunneis, septatis, laevibus, crassis compositum. Conidiophora semi-macronemata ad macronemata, mononemata, adscendentia ad erecta, recta vel flexuosa, simplicia vel interdum ramosa, cylindrica, ad apicem interdum inflata, pallide brunnea vel brunnea, laevia. Cellulae conidiogenae mono- vel polyblasticae, in conidiophoris incorporatae vel raro discretae, terminales vel intercalares, determinatae. Conidia acropleurogena, holoblastica, in catenis simplicibus vel ramosis acropetis formata, sicca, aseptata, laevia, sub-globosa vel ellipsoidea vel oblonga, pallide brunnea ad atrobrunnea, plerumque truncata.

Species typica: *Phaeblastophora resinae* (Fr. : Fr.) Partridge et Morgan-Jones.

*Phaeoblastophora* Partridge & Morgan-Jones, gen. nov.

Colonies effuse, black, scattered, often appearing mostly or occasionally restricted and orbicular by the presence of localized, discrete centers of conidiation; somewhat sparse when purely vegetative. Mycelium partly superficial and repent, partly immersed, composed of branched, brown, septate, smooth, wide, moderately thick-walled hyphae, with individual cells sometimes inflated resulting in apparent constriction at the septa. Conidiophores semi-macronematous to macronematous, mononematous, ascending to erect, straight or flexuous, simple or sometimes branched, cylindrical, often somewhat inflated at the apex, pale brown to brown, smooth. Conidiogenous cells mono- or polyblastic, integrated or, rarely, discrete, terminal or intercalary, determinate, often inflated to give an ampulliform, doliiform, or clavate aspect. Conidia acropleurogenous, holoblastic, in simple or branched acropetal chains, dry, unicellular, smooth, sub-globose or ellipsoid or oblong, pale brown to dark brown, often narrowly or broadly truncate at one or both ends.

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*[Note: nomenclatural and taxonomic synonyms in part derived from Hughes (1958).]

***Phaeoblastophora resinae*** (Fr. : Fr.) Partridge & Morgan-Jones, comb. nov. (Figure 1).

≡ *Myxotrichum resinae* Fr. : Fr., *Syst. Mycol.* 3:350, 1832.

≡ *Alysidium resinae* (Fr.) M.B. Ellis, Dematiaceous Hyphomycetes, p. 90, 1971.

= *Racodium aterrimum* Ehrenb., Sylv. mycol. berol., pp. 10, 22, 1818.

≡ *Acladium aterrimum* (Ehrenb.) S. Hughes, *Can. J. Bot.* 36:731, 1958.

= *Torula ramosa* Fuckel, Symb. Mycol., p. 348, 1870.

≡ *Oidium ramosum* (Fuckel) S. Hughes, *Can. J. Bot.* 36:731, 1953.

= *Trichosporium nigricans* Sacc., *Michelia* 2:125, 1880.

= *Dematium dimorphum* Karst., *Meddel. Soc. F. F. Fennica* 14:91, 1887.

Colonies effuse, black, scattered, often appearing mostly or occasionally restricted and orbicular by the presence of localized, discrete centers of conidiation; somewhat sparse when purely vegetative. Mycelium partly superficial and closely repent, partly immersed, composed of branched, brown, septate, smooth, moderately thick-walled, 2 to 7 µm wide hyphae, with individual cells sometimes inflated up to 11 µm wide, resulting in apparent constriction at the septa. Conidiophores semi-macronematous to macronematous, mononematous, ascending as upturned, lateral hyphal branches, sometimes more or less erect, straight or flexuous, simple or sometimes branched, varying in morphology and length, with a series of inflated intercalary cells or evenly cylindrical, almost invariably wider toward the apex, pale brown to brown, concolorous with the hyphae or darker, smooth, 4 to 8 µm wide, mostly up to 40 µm long, occasionally longer, up to 100 µm. Conidiogenous cells mono- or polyblastic, integrated, mostly terminal or, very occasionally, as discrete lateral branches, sometimes with a subterminal, intercalary conidiophore cell bearing a conidium, determinate, ampulliform to doliiform, pale brown to brown, evenly pigmented with subtending conidiophore cells or appreciably darker, particularly where terminal on both the main axis and short, lateral branches, occasionally disarticulating as oblong, widely-truncate, 9-14 X 4-8 µm elements. Conidia acropleurogenous, holoblastic, in simple or branched acropetal chains, dry, unicellular, smooth, sub-globose or ellipsoidal to somewhat limoniform, ranging from pale brown when immature to very dark brown, narrowly truncate at one or both ends, unthickened at the extremities, 7 to 11 µm in diameter where sub-globose, 9-14 X 6-8 µm in size where ellipsoidal.

On dead wood; cosmopolitan.

Specimens examined: on decaying wood, Pratts Falls, Onondaga County, New York, USA, C.J.K. Wang, 28 September 1966, SYRF [Wang 9995]; on decaying wood of beech, Allegheny State Park, Cattaraugus County, New York, USA, C.J.K. Wang, 29 July 1971, SYRF [Wang 11120];

In some respects *Phaeoblastophora resinae* has something of the aspect of the genera *Bispora* Corda and *Taeniolella* S. Hughes, both in colony growth characteristics and coloration, as well as in the morphology of the sometimes disarticulating conidiogenous cells. These elements are, interestingly, rather similar in shape to the conidia of certain species of the aforementioned genera, particularly those of *T. exilis* (P. Karst.) S. Hughes, which have the common characteristic of being widely truncate. It seems possible that the phylogenetic affinity of *P. resinae* lies with this complex rather than with the anamorphs of *Botryobasidium*.

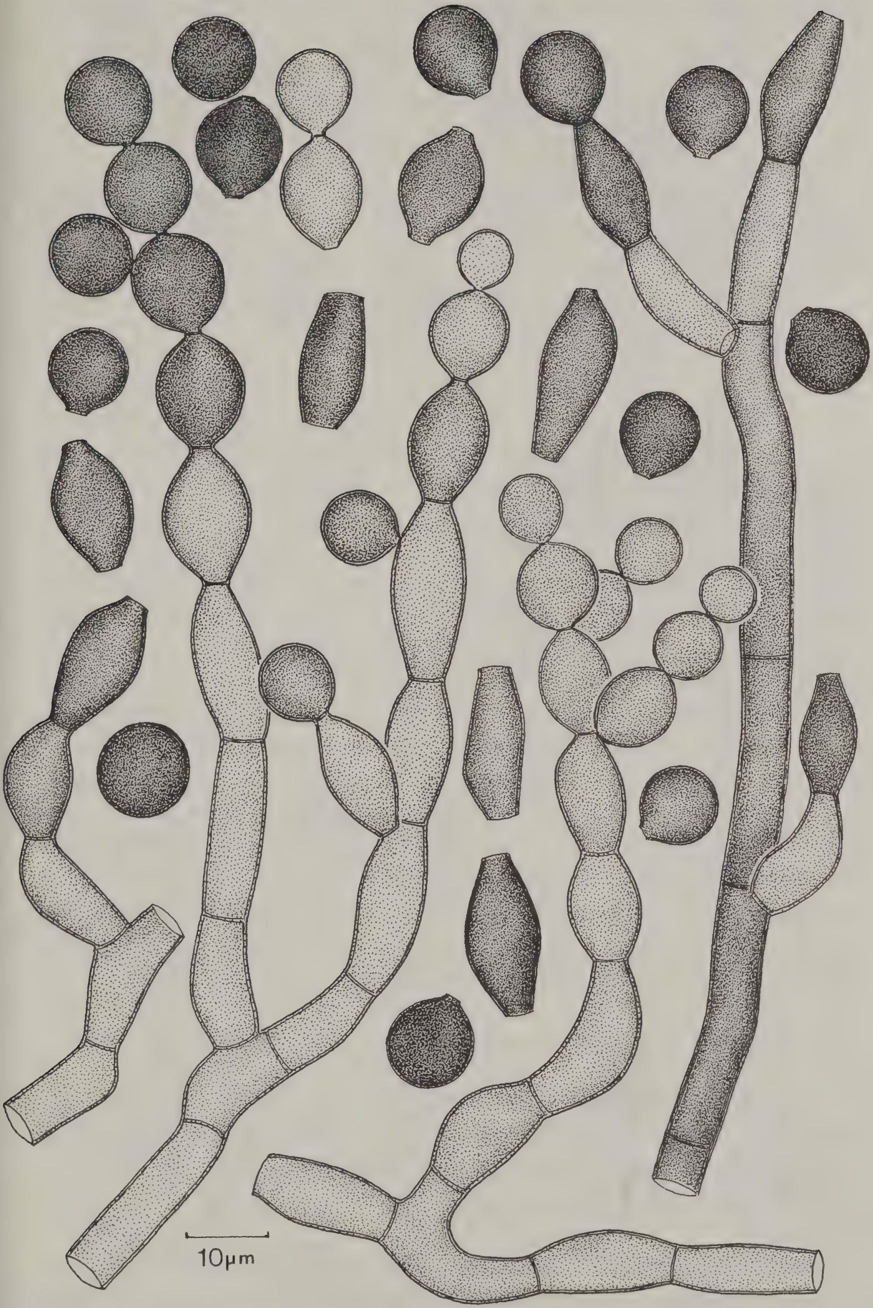

FIGURE 1. *Phaeoblastophora resinae*. Conidiophores and conidia.

***Phaeoblastophora peckii*** (Sacc. & Syd.) Partridge & Morgan-Jones, comb. nov. (Figure 2).

≡ *Torula peckii* Sacc. & Syd., in Sacc., *Syll. Fung.* 14:1070, 1899.

= *Torula ramosa* Peck, *NY State Mus. Rep.* 32:39, 1880 [non *Torula ramosa* Fuckel, 1870].

= *Alysidium resinae* (Fr.) M.B. Ellis var. *microsporum* B. Sutton, *Mycol. Pap.* 132:8, 1973.

Colonies effuse, black. Mycelium partly superficial, partly immersed, composed of branched, septate, mid brown to brown, smooth, 3 to 7 µm wide hyphae. Conidiophores semi-macronematous to, more often, macronematous, mononematous, arising as lateral branches of the repent hyphae, ascending, more or less erect, mostly straight to slightly flexuous, simple, cylindrical but usually inflated toward the extreme apex, brown to dark brown, darker distally, smooth, up to 200 µm long, 3 to 5 µm wide over most of the length, up to 8 µm wide terminally, 5 to 7 µm wide at the base. Conidiogenous cells mono- or mostly polyblastic, integrated, terminal or intercalary, determinate, broadly clavate to somewhat capitate and more deeply pigmented where terminal, cylindrical where intercalary, varying considerably in length, rarely disarticulating. Conidia acropleurogenous, holoblastic, in simple or branched acropetal chains, dry, unicellular, smooth, sub-globose to ellipsoidal, ranging from mid to very dark brown, generally paler when young but with degree of pigmentation sometimes independent of age and position, usually narrowly truncate at one or both ends, unthickened at the extremities, 5 to 8 µm in diameter where sub-globose, 8-11 X 5-8 µm in size where ellipsoidal.

On dead wood; North America.

Specimens examined: on decaying pine wood, North Greenbush, New York, USA, C.H. Peck, undated, NYS, holotype; on decaying hardwood, Green Lake State Park, Onondaga County, New York, USA, C.J.K. Wang, 3 November 1978, SYRF [Wang 11654].

*Phaeoblastophora peckii*, as noted by Sutton (1973), differs from *P. resinae* in possessing smaller conidia and appreciably longer conidiophores. This is particularly the case with regard to the diameter of the sub-globose

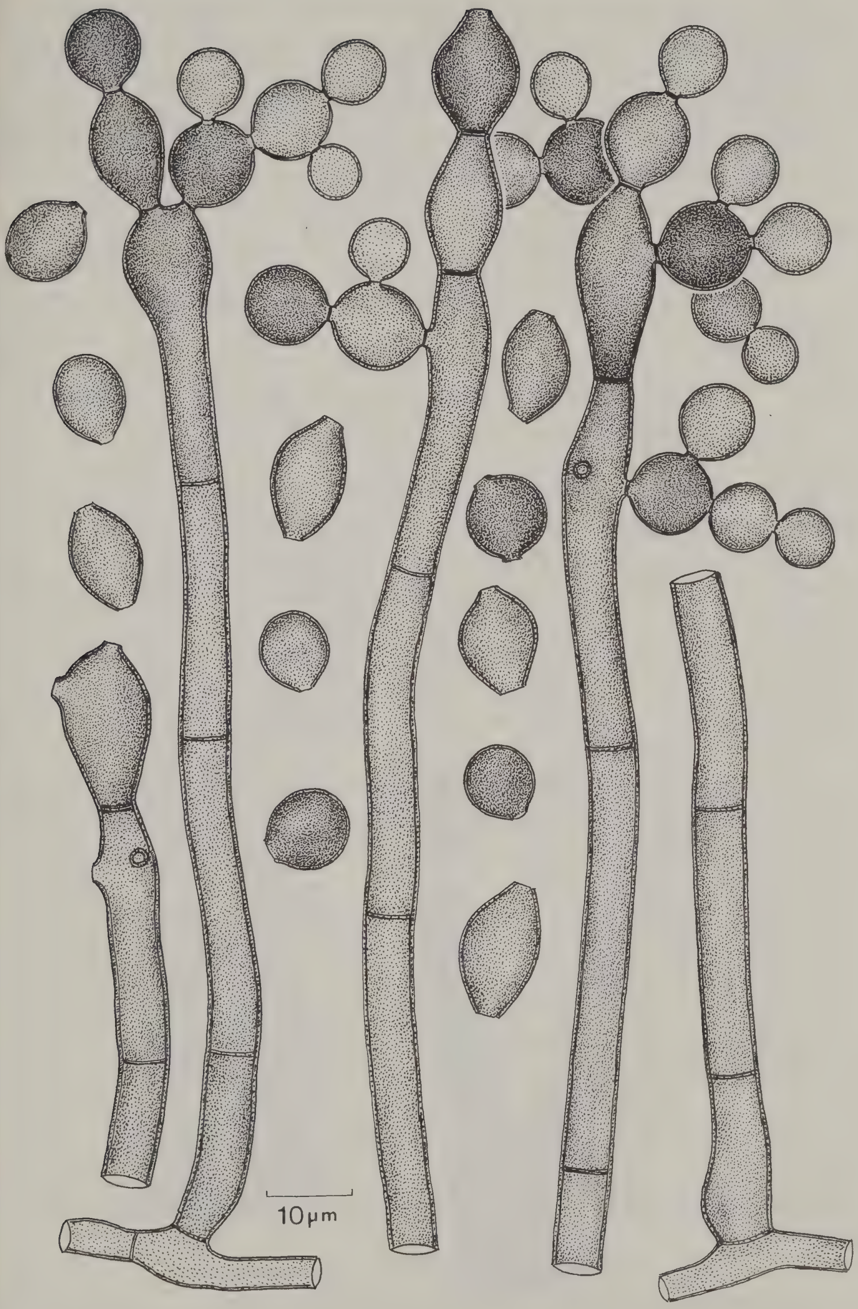

FIGURE 2. *Phaeoblastophora peckii*. Conidiophores and conidia.

conidia originating in chains. Ellis (1976), moreover, noted the conidiophores of *P. peckii* to be narrower. In addition to these distinctions, a number of morphological details serve to distinguish the two. These include shape of terminal conidiogenous cells and number of conidiogenous loci present, presence or absence of intercalary conidiophore cell inflation and branching, and extent of conidiogenous cell disarticulation.

*Sorocybe* Fr., *Summa Veg. Scan.* 2:468, 1849.

= *Pycnostysanus* Lindau, *Verh. Bot. Ver. Brandenb.* 45:160, 1904.

= *Hormoconis* Arx & G.A. de Vries, *Verh. K. Ned. Akad. Wet.*, Ser. 2, 61:62, 1973.

Note: the generic name *Hormoconis* is an additional nomenclatural synonym of *Sorocybe* since its type species is *H. resinae* (Lindau) Arx & G.A. de Vries [basionym: *Hormodendron resinae* Lindau, a binomial applied to the mononematous form of *Sorocybe resinae* (see Hughes, 1958)]. The question of whether or not this binomial has been misapplied to an entity [the anamorph of *Amorphotheca resinae* Parbery, to which de Vries (1952) applied the name *Cladosporium avellaneum* G.A. de Vries] other than the mononematous form of *Sorocybe resinae*, remains to be fully resolved.

Colonies effuse, spreading, dense, felted, black, brittle and appearing carbonaceous when dry. Mycelium mostly superficial, partly immersed, composed of branched, septate, smooth, brown hyphae. Conidiophores macronematous, predominantly synnematous and arranged as tight, stiff synnemata or, sometimes, mononematous, erect, more or less straight, branched distally, cylindrical, septate, mostly smooth, brown. Conidiogenous cells polyblastic, integrated terminally or as short, discrete, lateral branches, determinate. Conidia acropleurogenous, holoblastic, in simple or branched acropetal chains, dry, unicellular, smooth, fusiform to ellipsoid, or somewhat clavate when ramoconidial, pale brown to brown.

Type species: *Sorocybe resinae* (Fr.) Fr.

*Sorocybe resinae* (Fr.) Fr., *Summa Veget. Scan.* 2:468, 1849 (Figures 3 & 4).

≡ *Racodium resinae* Fr., *Obs. Mycol.* 1:216, 1815.

≡ *Sporocybe resinae* (Fr.) Fr., *Syst. Mycol.* 3:341, 1832.

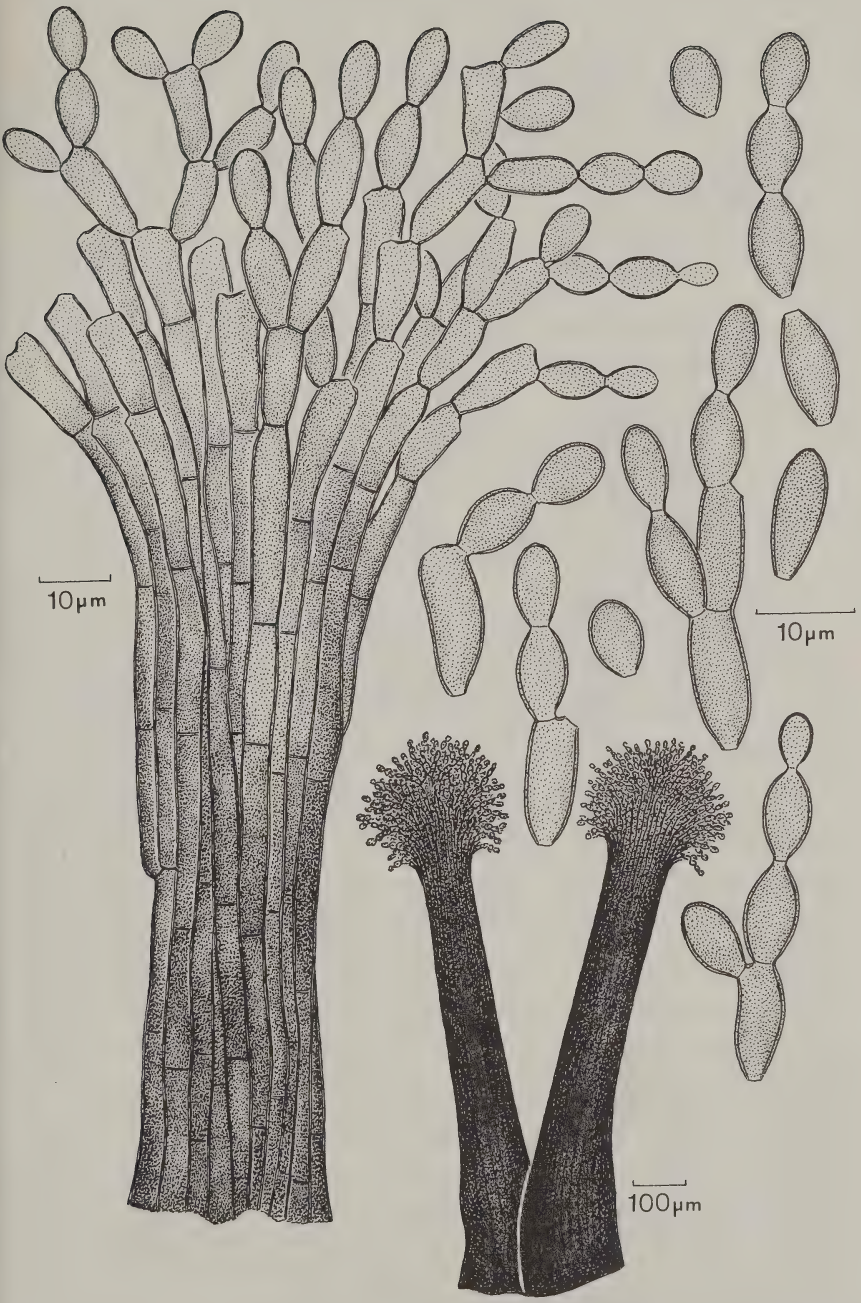
10µm
10µm
100µm

FIGURE 3. *Sorocybe resinae*. Synnemata, conidiophores and conidia.

≡ *Dendryphion resinae* (Fr.) Corda, *Icon. Fung.* 6:11, 1854.

≡ *Stysanopsis resinae* (Fr.) Ferraris, *Flora Ital. Crypt.* 1 (Fungi, Hyphales), p. 187, 1910.

= *Pycnostysanus resinae* Lindau, *Verh. Bot. Ver. Brandenb.* 45:160, 1904.

≡ *Stysanus resinae* (Lindau) Sacc., *Syll. Fung.* 18:651, 1906.

= *Hormodendron resinae* Lindau, in *Rabenh. Krypt.-Flora*, 2 Aufl., 1 (Pilze), 8:699, 1906.

≡ *Cladosporium resinae* (Lindau) G.A. de Vries, *Antonie van Leeuwenhoek, J. Microbiol. Serol.* 21:167, 1955.

≡ *Hormoconis resinae* (Lindau) Arx & G.A. de Vries, in Arx, *Verh. K. Ned. Akad. Wet.*, Ser. 2, 61:62, 1973.

Colonies effuse, spreading, dense, felted, black, brittle and appearing carbonaceous when dry, particularly well-developed when growing in or on resin. Mycelium mostly superficial, partly immersed, composed of branched, septate, smooth, brown, 2 to 5 µm wide hyphae. Conidiophores macronematous, predominantly synnematous and arranged as tight, stiff synnemata or, sometimes, mononematous, erect, more or less straight, branched towards the apex, where synnematal, flaring distally to form a conidium-bearing head, cylindrical, septate, mostly smooth, sometimes sparsely verruculose in the middle portion, brown, often slightly constricted at the septa delimiting terminal or subterminal cells, 3 to 6 µm wide. Synnemata erect, simple, determinate, composed of parallel hyphae which branch as conidiophores distally, broad at the base, up to 250 µm wide, attenuating to 40 to 100 µm wide for most of the length of the stipe, generally up to 2 mm long, with a capitate, fertile head. Conidiogenous cells polyblastic, integrated terminally or as short, discrete, lateral branches, determinate, cylindrical to narrowly clavate, very slightly rounded and protuberant at each conidiogenous locus, 7-12 X 4-7 µm in size. Conidia acropleurogenous, holoblastic, in simple or branched acropetal chains, with interconidial, delimiting septa relatively wide, dry, unicellular, smooth, fusiform to short ellipsoid, or somewhat clavate when ramoconidial, truncate at one or both ends, bearing no scar at the points of detachment, pale brown to brown, 5-11 X 3-6 µm in size.

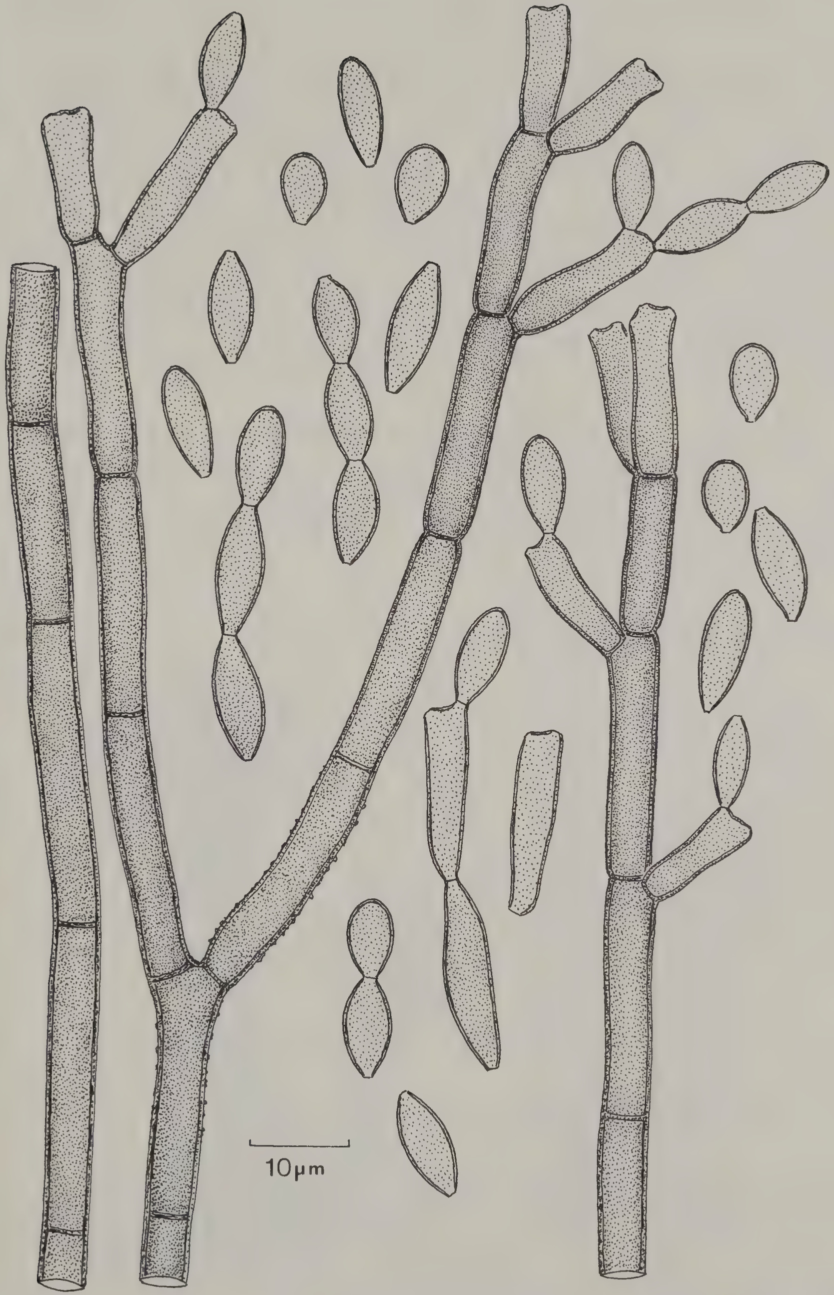

FIGURE 4. *Sorocybe resinae* (mononematous form). Conidiophores and conidia.

On resinous wood; cosmopolitan.

Specimens examined: on resin of spruce stake, Harz, Germany, G. Lindau, 13 August 1903 [Kabát et Bubák, Fungi imperfecti exsiccati 99], BPI, type; on resin of spruce stake, Harz, Germany, P. Sydow, 30 August 1904, BPI; on *Picea sitchensis* (Bong.) Carrière, Cape Perpetua, Devil's Elbow State Park[?], Oregon, USA, S.J. Hughes, 6 May 1969, BPI; on pith of Douglas fir [*Pseudotsuga menziesii* (Merb.) Franco], MacDonald Forest along Sulphur Springs Rd., Benton Co., 5 km north of Corvallis, Oregon, USA, A. Rossman & S. Carpenter, 26 June 1976, BPI; on resin of Douglas fir, forest near Winter Falls [122°30'W, 44°53'N], Silver Creek Falls State Park, east of Salem, Oregon, USA, A. Rossman & L. Pike, undated, BPI.

In nature, both the synnematous condition as well as the mononematous form of this anamorph can occur in close proximity to one another. Although there is some difference in the degree of individual conidiophore robustness between the two [see illustrations], their conidia are more or less identical.

***Seifertia*** Partridge et Morgan-Jones, gen. nov.

Coloniae effusae, farinaceae, griseae vel atrobrunneae. Mycelium immersum, ex hyphis ramosis, septatis, laevibus, brunneis compositum. Conidiophora macronemata, synnemata, recta vel leniter flexuosa, ramosa, cylindrica, septata, laevia, olivaceo-brunnea vel brunnea. Synnemata erecta, simplicia vel raro ramosa, atrobrunnea vel nigra, apice capitato. Cellulae conidiogenae mono- vel polyblasticae, in conidiophoris incorporatae, terminales, determinatae, cylindricae vel doliiformae. Conidia acropleurogena, holoblastica, in catenis simplicibus vel ramosis acropetis formata, sicca, aseptata vel raro uniseptata, laevia, oblonga vel ellipsoidea vel sub-globosa, pallide brunnea vel olivaceo-brunnea.

Species typica: *Seifertia azaleae* (Peck) Partridge et Morgan-Jones.

*Seifertia* Partridge & Morgan-Jones, gen. nov.

Colonies effuse, powdery, grey to dark brown. Mycelium immersed, composed of branched, septate, smooth, brown hyphae. Conidiophores macronematous, synnematous, straight or slightly flexuous, branched toward the upper reaches, cylindrical, septate, smooth, olivaceous-brown to brown. Synnemata erect, simple or very rarely branched, greenish when young, becoming dark brown to black at maturity, capitate at the apex.

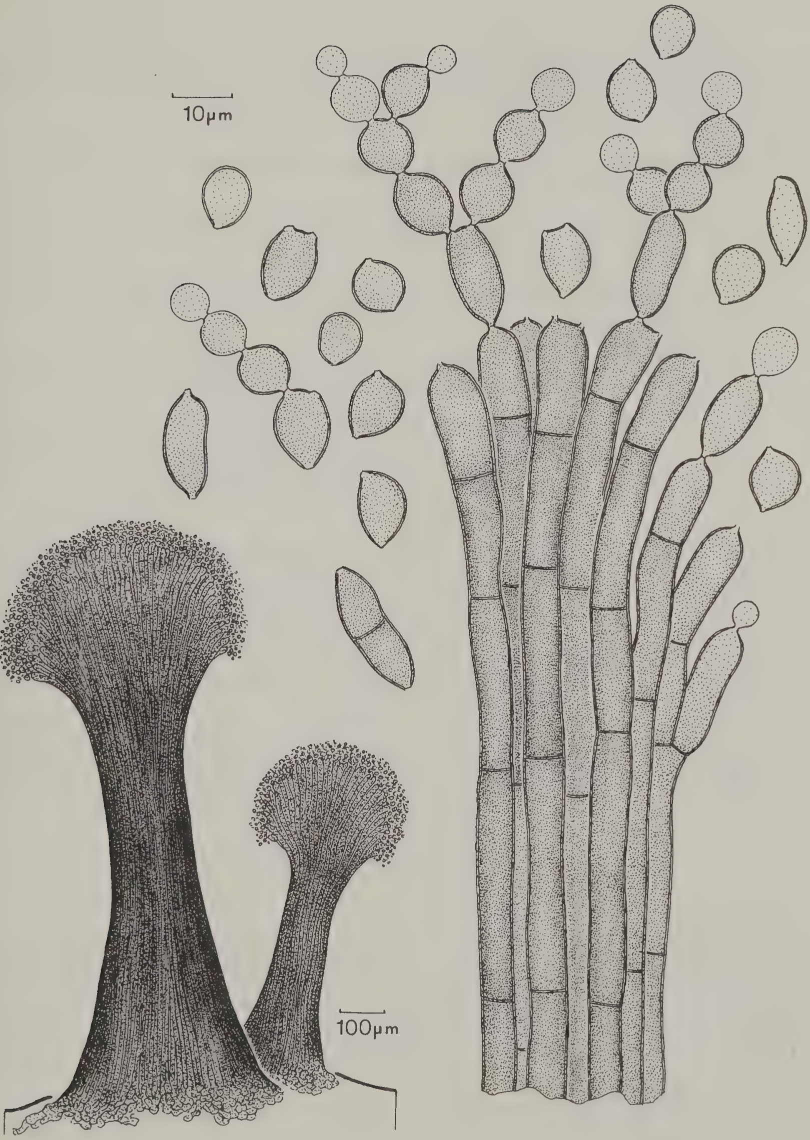

FIGURE 5. *Seifertia azaleae*. Synnemata, conidiophores and conidia.

Conidiogenous cells mono- or polyblastic, integrated, terminal, determinate, cylindrical or doliiform. Conidia acropleurogenous, holoblastic, in simple or branched acropetal chains, dry, unicellular or very rarely one-septate, smooth, oblong or ellipsoid or sub-globose, pale brown or olivaceous-brown.

Etymology: this genus is named in honor of Dr. Keith A. Seifert, Agriculture & Agri-Food Canada, Ottawa, in recognition of his distinguished contributions to knowledge of synnematous anamorphs.

***Seifertia azaleae*** (Peck) Partridge & Morgan-Jones, comb. nov. (Figure 5).

≡ *Periconia azaleae* Peck, *Ann. Rep. N. Y. St. Mus.* 25:93, 1873.

≡ *Sporocybe azaleae* (Peck) Sacc., *Syll. Fung.* 4:608, 1886.

≡ *Briosia azaleae* (Peck) Dearn., *Mycologia* 33:365, 1941.

≡ *Pycnostysanus azaleae* (Peck) E.W. Mason, Annotated Account of Fungi received at the Imperial Mycological Institute, List II (Fasc. 3- Special Part):130, 1941.

Colonies effuse, powdery, grey to dark brown, blackish when well developed and mature. Mycelium immersed, composed of branched, septate, smooth, brown, 3 to 5 µm wide hyphae. Conidiophores macronematous, synnematous, straight or slightly flexuous, branched toward the upper reaches and splaying out, cylindrical, septate, smooth, olivaceous-brown to brown, 4 to 7 µm wide. Synnemata erect, simple or very rarely branched, basipseudostromatic, arising from a dense mass of tightly interwoven hyphae, giving the aspect of a stromata, initially dark olivaceous, becoming dark brown to black, but with a capitate apex that appears, as a result of conidiation, green when fresh and remains somewhat paler, up to 1.5 mm high, broad at the base, up to 400 µm wide, attenuating to a narrower middle part. Conidiogenous cells mono- or polyblastic, usually with no more than two conidiation loci, integrated, terminal, determinate, cylindrical or doliiform, bearing a minute spicule at each locus of conidial detachment. Conidia acropleurogenous, holoblastic, in simple or branched acropetal chains, separated by short, narrow isthmi, dry, unicellular or very rarely one-septate, smooth, oblong or ellipsoid or sub-globose, shallowly apiculate, bearing no scar at point of detachment, pale brown or olivaceous-brown, 4-12 X 4-8 µm in size.

On *Rhododendron* species and cultivars; cosmopolitan.

Specimens examined: on *Rhododendron*, Richmond Park, Surrey, Great Britain, R.W.G. Dennis, 29 May 1950, BPI; on *Rhododendron*, Bushy Park, Middlesex, Great Britain, S.P. Wiltshire, 17 April 1954, BPI; on *Rhododendron 'grandiflora'*, Florence, Oregon, USA, S.J. Hughes, 13 August 1974, BPI.

*Seifertia azaleae* is the causal organism of bud blast and twig blight of azaleas and rhododendrons. Infected buds become readily discernible by being strikingly symptomatic through the development of numerous synnemata which appear as tiny black spines over the entire surface.

In reaching the decision to establish a separate genus for this taxon, traditional and well-established generic concepts, albeit primarily monothetically-based, are being followed. Although superficially similar to the synnematal form of *Sorocybe resinae* by having in common acropetal, holoblastically-produced, branched chains of conidia, there are subtle but significant distinctions between the two which lead us to believe that they are not phylogenetically related. In particular, the narrow, interconidial isthmi of *Seifertia azaleae* are markedly different from the condition in *Sorocybe resinae* where conidia are delimited by comparatively broad septa. The resultant morphological peculiarities which characterize *S. resinae* include possession of distinctly truncate detached conidia and broadly protuberant conidiation loci. In *S. azaleae* the presence of small spicules on conidiogenous cells, marking conidiation loci, is especially distinctive. The degree of difference between these taxa is of a similar order to that existing between them and certain other synnematous genera, such as *Briosia* Cavara. The fact that *S. azaleae* is a host-specific, virulently plant pathogenic fungus, whereas *S. resinae* is saprotrophic on resinous wood, lends credence to the view that they should be regarded as being unrelated and therefore taxonomically distant.

## ACKNOWLEDGMENTS

We are most grateful to Dr. Amy Y. Rossman [BPI] and Dr. C.J.K. Wang, State University of New York, Syracuse, for the loan of the specimens studied. We thank Dr. C.J.K. Wang for reviewing the manuscript and for drawing to our attention the morphological peculiarities of *Torula ramosa* Peck.

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# TWO NEW SPECIES IN THE LICHEN GENUS PERTUSARIA (ASCOMYCOTINA) FROM THAILAND

SUREEPORN JARIANGPRASERT

*Department of Biology, Faculty of Science, Chiang Mai University*
*Chiang Mai 50200, Thailand*
*email: s_vipoosunti@yahoo.com*

ALAN W. ARCHER

*National Hebarium of New South Wales,*
*Mrs. Macquaries Road, Sydney, N.S.W. 2000, Australia*
*email: alanw.archer@bigpond.com*

JOHN A. ELIX

*Department of Chemistry, Faculty of Science, Australian National University,*
*Canberra, A.C.T. 0200, Australia*
*email: John.Elix@anu.edu.au*

VILAIWAN ANUSARNSUNTHORN

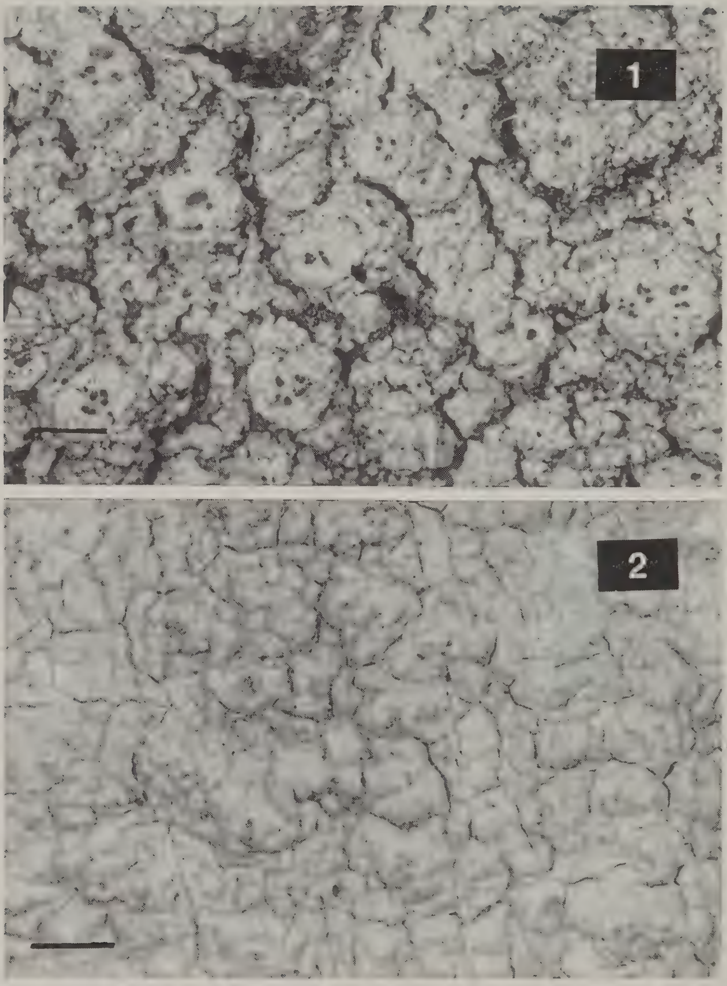
*Department of Biology, Faculty of Science, Chiang Mai University*
*Chiang Mai 50200, Thailand*

ABSTRACT: *Pertusaria nahaeoensis* and *P. omkoiensis* from Thailand are reported as new to science.

KEY WORDS: *Pertusaria nahaeoensis, Pertusaria omkoiensis,* alternariol

## INTRODUCTION

The lichen genus *Pertusaria* in Thailand has received little attention since the publications of E. Vainio who described four new species of *Pertusaria viz. P. bengalensis*, *P. sphaerulifera* and *P. subnegans* from Koh Chang Island (Vainio 1907, 1909) and *P. asiana* from Mount Doi Suthep (Vainio 1921). *Pertusaria asiana* also occurs in northeastern Australia, and *P. bengalensis* is a later synonym of *P. tropica* Vain. (Archer 1997). An examination of recent collections of *Pertusaria* in Thailand has revealed the presence of two new species which are described here.



Figures 1, 2. New species of *Pertusaria*: 1, *P. nahaeoensis* (holotype in RAMK); 2, *P. omkoiensis* (holotype in RAMK). Scale bar = 1.0 mm.

## MATERIALS AND METHODS

This account is based on the examination of specimens in RAMK (Lichen Research Unit, Ramkhamhaeng University, Bangkok) and recent collections by one of us (SJ). The techniques used for thin layer and high performance liquid chromatography follow standard methods (Elix & Ernst-Russell 1993; Feige *et al.* 1993).

## NEW SPECIES

**Pertusaria nahaeoensis** Jariangprasert & A.W. Archer, sp. nov. Fig. 1

Similis *Pertusaria indica* sed acidum 2-*O*-methylperlatolicum vice acidi 2'-*O*-methylperlatolici continens.

Type: THAILAND. Loei Province, Ban Bomeong District, Wat Pa Chareom Phakiat, Nahaeo National Park, 17°05'N, 101°05'E, 1000 m, on red sandstone in dipterocarpous forest, *N. Homchamtra s.n.*, 5.xi.1995; holotype RU 6691 (RAMK).

*Thallus* saxicolous, off-white to glaucous, surface cracked and subtuberculate, isidia and soredia absent. *Apothecia* numerous, verruciform, conspicuous, scattered or crowded, not confluent, concolorous with the thallus, constricted at the base, round or irregular in outline, the exciple with minute warts, 0.5-1.5 mm diam. *Ostioles* conspicuous, black, 0.05-0.2 mm diam., slightly sunken, sometimes grouped in a central depression, 4-many per verruca. *Ascospores* 2-3 per ascus, arranged longitudinally, contiguous, ellipsoid, (100-)110-142 μm long, (42-)46-66 μm wide, smooth; outer ascospore wall 8-20 μm thick.

**Chemistry:** K+ yellow, KC-, C-, Pd-, UV+ pale orange; 4,5-dichlorolichexanthone (minor), 2-*O*-methylperlatolic acid (major), atranorin (minor), alternariol (minor), alternariol methyl ether (minor), methyl baeomycesate (minor) and perlatolic acid (minor).

**Distribution and ecology:** *Pertusaria nahaeoensis* is a rare, endemic, saxicolous species known only from the type specimen from Nahaeo National Park, where it occurred on red sandstone in dipterocarpous forest at an elevation of 1000 m.

**Remarks:** *Pertusaria nahaeoensis* is characterised by the numeous black ostioles, asci with 2-3 ascospores and the presence of alternariol and its methyl ether with 4,5-dichlorolichexanthone. This combination of benzocoumarin and xanthone has only been reported once before, from *Pertusaria praecipua* A.W. Archer & Elix, from Papua New Guinea (Archer & Elix 1998). The new species resembles *P. indica* Srivastava & Awasthi (Awasthi & Srivastava 1993), but is distinguished from that species by the tuberculate thallus surface and the presence of 2-*O*-methylperlatolic acid; *P. indica* contains 2'-*O*-methylperlatolic acid (Archer 1995). The epithet *nahaeoensis* is derived from Nahaeo National Park, the type locality.

**Pertusaria omkoiensis** Jariangprasert & A.W. Archer, sp. nov. Fig. 2

Similis *Pertusaria leioplacella* Nyl. sed acidum isoplacodiolicum continens et ostiolis non flavis.

Type: THAILAND. Chiang Mai Province, Omkoi District, Ban Mae Toen, Omkoi Sanctuary, Unit 2, 17°38'N, 98°28'E, 1290 m, on bark of *Artocarpus heterophyllus* Lamk., *S. Jariangprasert 443,* 6.xii.1999; holotype: RAMK.

*Thallus* corticolous, greenish grey to glaucous, surface smooth, areolate and cracked, isidia and soredia absent. *Apothecia* inconspicuous, verruciform, scattered, rarely confluent, concolorous with the thallus, flattened-hemispherical, 0.5-1.10 mm diam. *Ostioles* inconspicuous, grey, scarcely raised, 1 per verruca. *Ascospores* 8 per ascus, irregularly biseriate, ellipsoid to subfusiform, 58-82 μm long, 26-36 μm wide, smooth; outer ascospore wall 3-6 μm thick.

**Chemistry:** K+ yellow, KC+ orange, C-, Pd-, UV+ bright orange; stictic acid (major), constictic acid (major), hypostictic acid (minor), thiophaninic acid (minor), isoplacodiolic acid (minor), 2,2'-di-*O*-methylstenosporic acid (minor) and planaic acid (minor).

**Distribution and ecology:** *Pertusaria omkoiensis* is a rare, endemic, corticolous species known only from the type specimen from Omkoi Sanctuary Unit 2, where it occurred on cultivated *Artocarpus heterophyllus* (Jackfruit) at an altitude of 1290 m.

**Remarks:** *Pertusaria omkoiensis* is characterised by asci with 8 ascospores, inconspicuous grey ostioles and the presence of thiophaninic and stictic acids. The new species resembles *P. leioplacella* Nyl. from New Caledonia (Nylander 1867), but differs from that species in the colour of the ostioles (pale yellow to yellow in *P. leioplacella*) and the presence of isoplacodiolic acid, 2,2'-di-*O*-methylstenosporic acid and planaic acid, which are absent in *P. leioplacella*. The epithet *omkoiensis* is derived from Omkoi Sanctuary, the type locality.

## ACKNOWLEDGEMENTS

One of us (SJ) is grateful to RAMK for the loan of specimens, to the Omkoi Sanctuary for permission to collect specimens and to the Department of Biology and Chemistry, Faculty of Science, Maejo University for the use of laboratories and equipment. This work was supported by the Royal Golden Jubilee Ph.D. Programme, The Thailand Research Fund.

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# NEW REPORTS OF CALICIOID LICHENIZED AND NON-LICHENIZED ASCOMYCETES FROM TAIWAN

Laurens B. Sparrius
*Kongsbergstraat 1, NL-2804 XV Gouda, The Netherlands*

André Aptroot
*Centraalbureau voor Schimmelcultures, P.O. Box 85167, NL-3508 AD Utrecht, The Netherlands*

Ming-Jou Lai *
*P.O. Box 834, Tunghai University, Taichung, Taiwan 407*

* corresponding author

**Abstract**: Nine species of calicioid ascomycetes are reported new to Taiwan, viz. *Calicium adspersum*, *C. glaucellum*, *C. hyperelloides*, *C. trabinellum*, *Chaenotheca brunneola*, *C. furfuracea*, *Chaenothecopsis pusiola*, *Cybebe gracilenta* and *Mycocalicium subtile*. Additional records are presented for *Bunodophoron diplotypum*, *B. formosanum* and *Sphaerophorus taiwanensis*.

**Keywords**: Coniocybaceae, Sphaerophoraceae, Caliciales, Caliciaceae.

Only very recently (Hsueh et al. 2001) a second crustose species of calicioid lichenized ascomycetes (species that were formerly classified in the order of the Caliciales) was reported from Taiwan, viz. *Chaenotheca chrysocephala* (Turn. ex Ach.) Th. Fr. Before, *Tylophoron moderatum* Nyl. was reported by Zahlbruckner (1933). During a collecting trip in October 2001 by the authors to various parts of the country, nine additional species of lichenized and non-lichenized calicioid ascomycetes have been discovered, especially in the central mountain ranges. They were mainly found on dead logs, but also on overhanging dry sides of ancient trees or on sheltered gravelly road sides. Some species were found only once, but others proved to be widespread and/or locally common.

The following species are new to Taiwan:

**Calicium adspersum** Pers.

Specimens examined: Taichung County: 22 km E of Tungshi, Tahsuehshan Forest Recreation Area, near entrance. 1500 m alt., UTM(WGS-84): 51RTG9482, on ancient tree, 8 Oct. 2001, *Aptroot 51842* (ABL) & *Sparrius 5786* (hb Sparrius).

Widely distributed in cool temperate areas in the world.

**Calicium glaucellum** Ach.

Specimens examined: Hualien County: Taroko National Park, Hohuan Shan, near Field Station, 3200 m alt., 51RUG260725, on coniferous wood, 12 Oct. 2001, *Sparrius 6175 & 6178* (hb Sparrius). Hualien County: 45 km WNW of Hualien, Meifeng, around field centre, 2100 m alt., 51RUG1464, on *Cryptomeria japonica*, 9 Oct. 2001, *Aptroot 51244 & 52145* (ABL). Hualien County: 45 km WNW of Hualien, Meifeng, broadleaf forest remnant on ridge, 2050 m alt., 51RUG145645, on *Michelia formosana*, 10 Oct. 2001, *Aptroot 52327a* (ABL).

Widely distributed in cool temperate areas in the world.

**Calicium hyperelloides** Nyl.

Specimens examined: Hualien County: Taroko National Park, Hohuan Shan, *Pseudotsuga* forest, 2950 m alt, 51RUG231686, on wood of *Pseudotsuga wilsoniana*, 13 Oct. 2001, *Sparrius 6369* (hb Sparrius). Hualien County: 45 km WNW of Hualien, Meifeng, broadleaf forest remnant on ridge, 2050 m alt., 51RUG145645, on *Michelia formosana*, 10 Oct. 2001, *Aptroot 52327* (ABL).

This species is common in tropical areas around the world.

**Calicium trabinellum** (Ach.) Ach.

Specimen examined: Hualien County: 45 km WNW of Hualien, Meifeng, broadleaf forest remnant on ridge, 2050 m alt., 51RUG145645, on wood, 10 Oct. 2001, *Aptroot 52333* (ABL).

Widely distributed in cool temperate areas in the world.

**Chaenotheca brunneola** (Ach.) Müll. Arg.

Specimens examined: Hualien County: Taroko National Park, Hohuan Shan, near Field Station, 3200 m alt., 51RUG260725, on wood, with *Chaenothecopsis lignicola*, 12 Oct. 2001, *Aptroot 52684* (ABL) & *Sparrius 6176* (hb Sparrius). Taichung County: 30 km ENE of Taichung, 7 km NW of Kukwan, along mountain trail, 1000-1300 m alt., 51RTG9279, on decaying wood, 20 Oct. 2001, *Aptroot 53490* (ABL) & *Sparrius 5196* (hb Sparrius). Hualien County: 43 km WNW of Hualien, Meifeng, broadleaf forest remnant near field centre, 2100 m alt., 51RUG1566, on *Shiia carlesii* wood, 11 Oct. 2001, *Aptroot 52409* (ABL). Hualien County: 44 km WNW of Hualien, Meifeng, broadleaf forest remnant in valley, 2050 m alt., 51RUG146655, on *Shiia* wood, 10 Oct. 2001, *Aptroot 52258* (ABL).

This species is widely distributed in boreal and temperate zones on both hemispheres.

**Chaenotheca furfuracea** (L.) Tibell

Syn.: *Coniocybe furfuracea* (L.) Ach.

Specimens examined: Hualien County: 43 km WNW of Hualien, Meifeng, broadleaf forest remnant near field centre, 2100 m alt., 51RUG1566, on shaded schistose rock on roadbank, 11 Oct. 2001, *Aptroot 52484, 52485 & 52489* (ABL) & *Sparrius 6091* (hb Sparrius). Hualien County: Taroko National Park, Hohuan Shan, near Field Station, 3200 m alt., 51RUG260725, on wood, 12 Oct. 2001, *Aptroot 52689* (ABL).

This species is widely distributed in the Northern Hemisphere.

**Chaenotheca gracilenta** (Ach.) Middelb. & Mattsson

Specimens examined: Hualien County: Taroko National Park, Hohuan Shan, near Field Station, 3200 m. alt., 51RUG260725, on overhanging schistose rock, 12 Oct. 2001, *Aptroot 52690* (ABL) & *Sparrius 6173* (hb Sparrius). Same locality, on wood, 12 Oct. 2001, *Sparrius 6186* (hb Sparrius).

This species is rather rarely reported, but widely distributed in the Northern Hemisphere (Tibell 1999, 2001). Tibell (2001) proved that this species, formerly placed in the monotypic genus *Cybebe*, belongs to *Chaenotheca*.

**Chaenothecopsis pusiola** (Ach.) Vain.

Syn.: *Chaenothecopsis lignicola* (Nádv.) A.F.W. Schmidt

Specimens examined: Hualien County: Taroko National Park, Hohuan Shan, near Field Station, 3200 m alt., 51RUG260725, on wood, with *Chaenotheca brunneola*, 12 Oct. 2001, *Aptroot 52688* (ABL) & *Sparrius 6445* (hb Sparrius).

New to tropical Asia. This species is rare but widely distributed in boreal zones in the Northern Hemisphere and also known from New Zealand (Tibell 1987). Our specimen is growing intermixed with *Chaenotheca brunneola* and could therefore be considered as parasymbiontic.

**Mycocalicium subtile** (Pers.) Szatala

Specimens examined: Hualien County: Taroko National Park, Hohuan Shan, near Field Station, 3200 m. alt., 51RUG260725, on wood, 12 Oct. 2001, *Aptroot 52698* (ABL) & *Sparrius 6181* (hb Sparrius).

This species is widely distributed in temperate zones in the world.

Additional records are presented here of Sphaerophoraceae already reported from Taiwan by Wang-Yang & Lai (1976):

**Bunodophoron diplotypum** (Vain.) Wedin

Specimen examined: Taichung County: 22 km E of Tungshi, Tahsuehshan Forest Recreation Area, near entrance. 1500 m alt., 51RTG9482, on tree, 8 Oct. 2001, *Aptroot 51851* (ABL).

This species has a wide distribution in East Asia, and is furthermore known from Australia, Madagascar and Tanzania (Wedin 1995).

**Bunodophoron formosanum** (Zahlbr.) Wedin

Specimens examined: Hualien County: 43 km WNW of Hualien, Meifeng, broadleaf forest remnant near field centre, 2100 m alt., 51RUG1566, on mature *Cyclobalanopsis*, 11 Oct. 2001, *Aptroot 52413* (ABL) & *Sparrius 6071* (hb Sparrius); Same locality, on *Shiia carlesii*, 11 Oct. 2001, *Aptroot 52493* (ABL). Hualien County: Taroko National Park, Hohuan Shan, near Field Station, 3200 m. alt., 51RUG260725, on *Abies kawakamii*, 12 Oct. 2001, *Aptroot 52602* (ABL). Taichung County: 22 km E of Tungshi, Tahsuehshan Forest Recreation Area, near entrance. 1500 m alt., 51RTG9482, on *Cryptomeria japonica*, 8 Oct. 2001, *Aptroot 51802* (ABL). Miaoli County: Shei-Pa National Park, 25 km ENE of Tungshi, near Tahsuehshan, at km 48. 1600 m alt., 51RTG996866, on *Picea morrisonicola*, 8 Oct. 2001, *Aptroot 51929* (ABL).

This species has a wide distribution in tropical mountain areas in the world.

**Sphaerophorus taiwanensis** Wang-Yang & M.-J. Lai

Specimens examined: Hualien County: Taroko National Park, Hohuan Shan, near Field Station, 3200 m alt., 51RUG260725, on *Abies kawakamii*, 12 Oct. 2001, *Aptroot 52603 & 52604* (ABL) & *Sparrius 6146* (hb Sparrius). Hualien County: Taroko National Park, Hohuan Shan, roadside with relict mature trees, 3200 m. alt., 51RUG2572, on *Abies kawakamii*, 13 Oct. 2001, *Aptroot 52816* (ABL). Hualien County: Taroko National Park, Hohuan Shan, mountain pass, 3300 m alt., 51RUG247705, on acid soil and plant debris, 13 Oct. 2001, *Sparrius 6312* (hb Sparrius). Hualien County: Taroko National Park, Hohuan Shan, *Pseudotsuga* forest, 2950 m alt, 51RUG231686, on bark of *Pseudotsuga wilsoniana*, 13 Oct. 2001, *Aptroot 52951 & 52952* (ABL).

This species is endemic to Taiwan, where it is locally abundant.

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# GRAPHIDACEAE (ASCOMYCOTINA) FROM THE SOLOMON ISLANDS: NEW SPECIES FROM GUADALCANAL

ALAN W. ARCHER

National Herbarium of New South Wales,
Royal Botanic Gardens, Sydney, NSW 2000, Australia

ABSTRACT: *Graphina austenensis, G. hillii, G. subelmeri, Graphis leptalocarpa, G. patula, Phaeographina amnicola* and *P. megalospora* from Guadalcanal are described as new to science.

The Solomon Islands, formerly the British Solomon Islands Protectorate, are a group of five major islands (Choiseul, Santa Isabel, Malaita, Guadacanal and San Cristobal) and several smaller islands, including New Georgia Island and Kolombangara Island, lying to the east of Papua New Guinea and to the north-east of Australia, between latitudes 6° and 12° South, and longitudes 156° and 163° East.

In 1965 the Royal Society organised an expedition to study the natural history of the islands, the first such expedition since the investigations of H.B. Guppy in 1882-3 on the survey ship H.M.S. Lark (Corner 1969). During the course of the 1965 expedition 461 lichen specimens in the family Graphidaceae were collected by D.J. Hill. The results of the expedition were discussed at a meeting of the Society held in March 1968 and these were published in 1969 (Corner 1969); no account of the lichens was included in this discussion. Sixteen genera of lichens are recorded from the Solomon Islands but none of these are from the family Graphidaceae (Elix & McCarthy1998).

This account is based on the specimens collected by D.J. Hill on Guadalcanal in 1965. The techniques used for microscopic examination, thin-layer chromatography and liquid chromatography have been described elswhere (Archer 2001).

**Graphina austenensis** A.W. Archer, *sp. nov.* Fig. 1A

Similis *Graphina triphoroides* Hale sed excipulo hinnulo et ascosporis minoribus differt.

Type: SOLOMON ISLANDS, Guadalcanal, central part, near Honiara, Mount Austen, near summit in lowland rain forest, alt. ca. 500 m, *D.J. Hill 10098*, 27.vii.1965; holotype: BM.

*Thallus* pale greenish-brown, thin, corticolous; surface slightly tuberculate and shiny; *apothecia* lirelliform, white, conspicuous, numerous, scattered, straight, curved or sinuous, sessile, lips closed, 0.6-4 mm long, 0.35-0.5 mm wide, with a thick pruinose coating; *proper exciple* uncarbonised, pale fawn, complete; *hymenium* 100-120 μm tall, I-ve; *ascospores* ellipsoid, hyaline, 8 per ascus, irregularly 1-seriate, 22-30 μm long, 11-14 μm wide, 6-7 x 2-3 locular, I+ blue.

*Chemistry*: stictic acid.

*Graphina austenensis* is characterised by the conspicuous, white lirellae, the absence of a carbonised proper exciple and the presence of stictic acid. The species resembles *Graphina triphoroides* Hale (Wirth & Hale 1978) but is distinguished from that species by the uncarbonised proper exciple (laterally carbonised in *G. triphoroides*) and the smaller ascospores, 23-30 μm long as compared to 47-75 μm long in *G. triphoroides*. Superficially the new species resembles *Graphis afzelii* but is distinguished from that species by the muriform ascospores, the presence of stictic acid and the absence of a carbonised exciple. The species is so far known only from the type specimen.
The epithet *austenensis* is derived from the type locality, Mount Austen.

**Graphina hillii** A.W. Archer, *sp. nov.* Fig. 1B

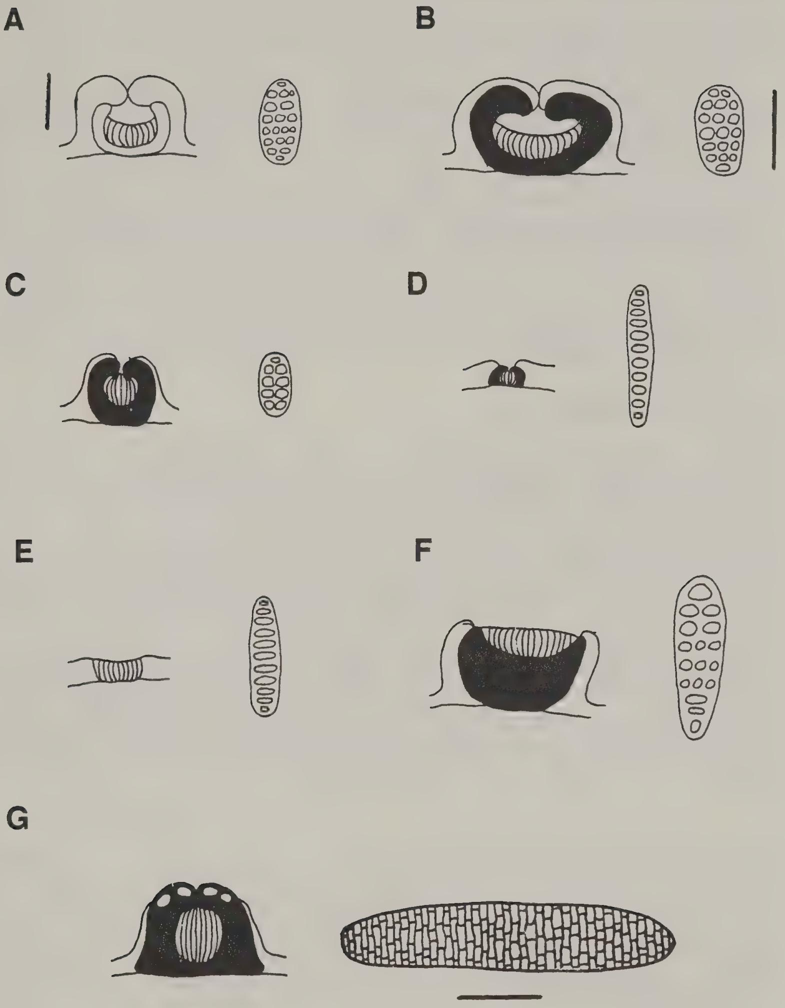
Similis *Graphis afzelii* Ach. sed ascosporis muriformis et acidum subpsoromicum vice acidi lecanorici continens differt.

Type: SOLOMON ISLANDS, Guadalcanal, central part, Sutakiki River, on ridge on S side, ca. 3 km from its confluence with Balsuna River, alt. ca. 400-600 m, *D.J. Hill 9160*, 27.x.1965; holotype: BM.

*Thallus* pale green, thin to evanescent, corticolous; surface smooth and shiny; *apothecia* lirelliform, white, becoming black where abraded, conspicuous, sessile, numerous, scattered, simple, straight or rarely curved, 1.2-2.2 mm long, 0.6-0.8 mm wide, lips closed; *proper exciple* completely carbonised, covered by a thin, white pruinose layer; *hymenium* 120-200 μm tall, I-ve; *ascospores* ellipsoid, hyaline, 8 per ascus, irregularly 1-seriate, 22-26 μm long, 10-12 μm wide, 6 x 2-3 locular, I+ yellow.

*Chemistry*: (hplc): subpsoromic acid (major), psoromic acid (minor) and 2'-*O*-demethylpsoromic acid (trace).

*Graphina hillii* is characterised by the conspicuous white lirellae, the completely carbonised proper exciple and the presence of subpsoromic acid. Externally the species resembles *Graphis afzelli* but is distinguished from that species by the muriform ascospores, the completely carbonised proper exciple and the presence of subpsoromic acid. *G. hillii* is distinguished from the new species *G. austenensis, q.v.,* by the carbonised proper exciple and chemistry. *G hillii* is so far known only from the type specimen which is named after the collector, D.J. Hill.



Figures 1A-G; Lirellae and Ascospores

A: *Graphina austenensis*; B: *G. hillii*; C: *G. subelmeri*; D: *Graphis leptalocarpa*; E: *G. patula*; F: *Phaeographina amnicola*; G: *P. megalospora*.

Lirellae: bar = 200 $\mu$m; ascospores: bar = 20 $\mu$m, except G, bar = 50 $\mu$m

## **Graphina subelmeri** A.W. Archer, sp. nov. Fig. 1C

Similis *Graphina elmerii* (Vain.) Zahlbr. sed ascosporis minoribus differt.

Type: SOLOMON ISLANDS. Guadalcanal, central part, Mount Popomanisu, on ridge SE of Sutakiki River ('top camp'), alt. ca. 1700 m, *D.J. Hill 9637*, 7.xi.1965; holotype: BM.

*Thallus* pale fawn, corticolous, surface smooth and dull; *apothecia* lirelline, black, conspicuous, scattered, straight, curved or sinuous, sometimes branched, initially subimmersed, becoming sessile, 2-4 mm long, 0.25-0.35 mm wide, sometimes with a thin thalline coating, partially lost due to abrasion, lips closed; *proper exciple* completely carbonised; *hymenium* 120-130 μm tall; *ascospores* ellipsoid, hyaline, 8 per ascus, 1-seriate, 18-20 μm long, 8-10 μm wide, 4 x 2 locular, I+ weak blue.

*Chemistry*: protocetraric acid.

*Graphis subelmeri* is characterised by the completely carbonised proper exciple, the small ascospores and the presence of protocetaric acid. The chemically and morphologically similar species, *Graphina elmeri* (Vain.) Zahlbr. differs in possessing larger ascospores, 100-130 x 22-34 μm (Vainio 1921) when compared with the ascospores in *G. subelmeri* which are 18-20 μm long. The two chemically similar Australian species *G. laevigata* (Müll. Arg.) A.W. Archer and *Graphina pertenella* (Stirt.) Shirley differ from the new species in lacking a carbonised exciple and possessing smaller ascospores *viz:* 9-14 μm long. The new species somewhat resembles *Graphina cremicolor* Magn. from Hawaii (Magnusson 1955) but the lirellae in that species are immersed and the specimen is reported to react K+ red, suggesting the presence of norstictic acid. The new species is so far known only from the type specimen. The epithet *subelmeri* is derived from Vainio's epithet *elmeri.*

## **Graphis leptalocarpa** A.W. Archer, *sp. nov.* Fig. 1D

Similis *Graphis arecae* Vain. sed cortice laevique nitido et ascosporis longioribus.

Type: SOLOMON ISLANDS. Guadalcanal, central part near Honiara, Mount Austen, near summit, lowland rain forest, alt. *ca.* 500 m, *D.J. Hill 10120*, 27.vii.1965; holotype: BM.

*Thallus* pale greenish-fawn, thin, corticolous, surface smooth and shiny. *apothecia* lirelline, black, inconspicuous, immersed, irregularly branched, 1-5 mm long, 0.05-0.1 mm wide, lips closed; *proper exciple* laterally carbonised; *hymenium* 80-100 μm tall, I-ve; *ascospores* 8 per ascus, irregularly 2-seriate, elongate ellipsoid, hyaline, 32-42 μm long, 6-7 μm wide, 10-12 locular, I+ blue.

*Chemistry*: stictic acid.

*Graphis leptalocarpa* is characterised by the smooth cortex, the immersed, black lirellae with laterally carbonised exciples and the presence of stictic acid. It resembles the chemically similar *G. arecae* Vain. (Vainio 1921) in that both species have immersed black lirellae with laterally carbonised proper exciples but the ascospores in *G. arecae* are smaller, 20-30 μm long, 6-10 locular, compared to 32-42 μm long, 10-12 locular in *G. leptalocarpa*. The new species also resembles *Graphis leptogramma* Nyl. from New Caledonia (Nylander 1868); both species possess thin black, immersed lirellae with laterally carbonised proper exciples and contain stictic acid but the ascospores in *G. leptogramma* are 45-66 μm long and 14-16 locular, and in addition the thallus is green, in contrast to the pale greenish-fawn thallus in *G. leptalocarpa*. The epithet *leptalocarpa* is from the Greek, *leptaleos*, fine, delicate, and *carpos*, fruit, a reference to the thin lirellae.

*Also examined*:
Guadalcanal, NW end, Mount Gallego, Hidden Valley, along valley bottom near old mining camp, on tree by stream, alt. ca. 330 m, *D.J. Hill 8133*, 6.vii.1965 (BM).

### **Graphis patula** A.W. Archer, *sp. nov.* Fig. 1E

Similis *Graphis hypolepta* Nyl. sed ascosporis longioribus et acidum sticticum continens differt.

Type: SOLOMON ISLANDS. Guadalcanal, NW end, Mount Gallego, middle to top of Monitor Creek, on *Canangra odorata* in forest opening by river, alt. *ca.* 170-330 m, *D.J. Hill 8256*, 9.vii.1965; holotype: BM.

*Thallus* greyish-white, slightly cracked, corticolous, surface smooth and dull; *apothecia* lirelline, immersed, inconspicuous, irregularly branched, 1-2 mm long, 0.05 mm wide, lips open; *epithecium* brown, epruinose; *proper exciple* lacking; *hymenium* 100-120 μm tall. I-ve; *ascospores* elongate ellipsoid, hyaline, 28-40 μm long, 8-9 μm wide, 9-11 locular, I+ blue.

*Chemistry*: stictic acid.

*Graphis patula* is characterised by the immersed, open lirellae, which lack a carbonised proper exciple, and the presence of stictic acid. The new species is distinguished from the superficially similar *Graphis hypolepta* Nyl. (Nylander 1863) by the presence of stictic acid (absent from *G. hypolepta*) and the longer ascospores, 28-40 μm long, 9-11 locular, compared with 21-32 μm long, 8 locular (Nylander, *in sched*. H-NYL 7674). Redinger (1936) and Magnusson (1955) report the ascospores in *G. hypoleta* to be 20-24 μm long and 8 locular. Superficially the new species resembles *Phaeographis ceratoides* (Vain.) Zahlbr. but that species has brown, 4-locular ascospores, 10-12 μm long and lacks lichen compounds. The epithet *patula* is from the Latin *patulus*, open, spread out, a reference to the open lirellae.

*Also examined*:
Guadalcanal, NW end, Mount Gallego, between bottom of Hidden Valley and top of Monitor Creek, alt. *ca.* 270-330 m, *D.J. Hill 8247*, 9.vii.1965 (BM).

**Phaeographina amnicola** A.W. Archer, *sp. nov.* Fig. 1F

Similis *Phaeographina quassiicola* (Fée) Müll. Arg. sed basi excipulo crassiore et ascosporis minoribus differt.

Type: SOLOMON ISLANDS. Guadalcanal, NW end, Mount Gallego, Hidden Valley, along valley bottom near old mining camp, alt. ca. 330 m, on log in stream, *D.J. Hill 8133*, 6.vii.1965; holotype: BM.

*Thallus* pale fawn, thin, corticolous, surface smooth and shiny; *apothecia* lirelline, conspicuous, scattered, simple straight, curved or sinuous, sessile, 1-4 mm long, 0.4-0.6 mm wide, open, with a conspicuous thalline margin; *epithecium* black, white pruinose; *proper exciple* completely carbonised, with a thickened base; *hymenium* 150-170 μm tall; *ascospores* 8 per ascus, pale brown tapering ellipsoid, muriform only at the wider end, (36-) 44-60 μm long, 12-16 μm wide, 9-11 x 1-3 locular.

*Chemistry*: no lichen compounds found.

*Phaeographina amnicola* is characterised by the conspicuous open lirellae, with the proper exciple completely carbonised with a thickened base, and the absence of lichen compounds. The species resembles *P. quassiicola* but the ascospores in that species are regularly ellipsoid and larger, being 65-100 μm long compared to 36-60 μm in *P. amnicola*. In addition, the base of the proper exciple is considerably thickened in *P. amnicola* when compared with that of *P. quassicola*.
The epithet *amnicola*, is from the Latin, dwelling by the side of a stream. The species is so far known only from the type specimen.

**Phaeographina megalospora** A.W. Archer, *sp. nov.* Fig. 1G

Similis *Phaeographina hadrospora* A.W. Archer sed excipulo nigro differt.

Type: SOLOMON ISLANDS. Guadalcanal, Mount Popomanisu, on ridge on SE of Sutakiki River (Vunuvalukama), alt. ca. 1300 m, in montane rainforest, *D.J. Hill 9790*, 9.xi.1965; holotype: BM.

*Thallus* pale fawn, thin, corticolous, surface smooth and shiny; *apothecia* lirelline, conspicuous, black, scattered, simple. sessile, lips closed, 1-2 mm long, 0.3-0.7 mm wide, perforated longitudinally, with a partial, thin thalline margin; *proper exciple* completely carbonised; *hymenium* 250-260 μm tall; *ascospores* 1 per ascus, pale brown, elongate ellipsoid, densely muriform, 200-230(-240) μm long, 42-54 μm wide

Chemistry: no lichen compounds found.

*Phaeographina megalospora* is characterised by the black, sessile lirellae, the large ascospores and the absence of lichen compounds. It is distinguished from the Australian species *P. hadrospora* A.W. Archer by the carbonised exciple, absent in *P. hadrospora*. Other *Phaeographina* species with large ascospores include *P. phlyctidiformis* Müll. Arg., (Müller 1892) from India (ascospores 160-200 μm long), and *P. balfourii* Müll. Arg., (Müller 1888) from Socotra (ascospores 190 μm long) but both species lack a carbonised proper exciple. *Phaeographina montagnei* (Bosch) Müll. Arg. (ascospores 140-180 μm long) has a carbonised exciple but the hymenium in this species is red; *P. macrospora* (Zahlbr.) Nakanishi was later reported to be a synonym of *P. montagnei* (Nakanishi 1977). The proper exciple in *P. echinocarpica* A.W. Archer & Elix (ascospores 162-200 μm long) is laterally carbonised and the species contains echinocarpic acid (Archer & Elix 1999) and is thus distinct from *P. megalospora*. *Phaeographina crassa* (Müll. Arg.) Redinger, from Brazil, also has large ascospores, 120-180 x 25-30 μm and a completely carbonised proper exciple but this species contains stictic acid (Staiger & Kalb 1999). The new species is so far known only from the type specimen.

The epithet *megalospora*, large spore, refers to the large ascospores.

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# NEW RECORDS OF SOIL-ASSOCIATED LICHENS FROM NORTH-EASTERN PATAGONIA (CHUBUT, ARGENTINA)

**Nora C. Scutari*, B. Doris Diez** & H. Thorsten Lumbsch#**

*Centro Nacional Patagónico, CONICET, Boulevard Brown s/n, CC 128,
9120 Puerto Madryn, Chubut, Argentina - e-mail: scutari@cenpat.edu.ar
** Universidad Nacional de la Patagonia San Juan Bosco, Boulevard Brown 3700,
CC 164, 9120 Puerto Madryn, Chubut, Argentina
# Universität Essen, Fachbereich 9/Botanik, Universitätsstraße 5, D-45117 Essen, Germany

*Abstract* - The present study describes preliminary floristic results of a project focusing on the use of lichens as bioindicators of rangeland conservation in the surroundings of Puerto Madryn (Chubut, Argentina). Two species are recorded for South America for the first time: *Fulgensia subbracteata* and *Rinodina mucronatula.* Three additional species are new records for Argentina: *Aspicilia contorta*, *Catapyrenium squamulosum* and *Lecanora dispersa.* The presence of *Endocarpon pusillum* is confirmed. The known distribution areas of two species, *Psora decipiens* and *Rinodina bischoffii*, are extended to parallel 42°S. Descriptions, comments and illustrations are provided.

**Key words:** floristics, rangelands, South America

## INTRODUCTION

Information on lichens from the Patagonian steppe is scarce and scattered in the literature (Cengia Sambo, 1930; Grassi, 1950). As far as Chubut Province is concerned, the north-eastern area which belongs to the Monte phytogeographical Province (Cabrera, 1976; ca. 5% of Chubut) has been more intensely collected, as shown by the 97 species recorded for this region, in contrast to the twelve species cited for the rest of the Province (Calvelo, 1998a).

It is well known that lichens, bryophytes and algae form crusts on soil surface, which play important ecological roles in arid and semiarid regions (Eldridge & Rosentreter, 1999). Such cryptogamic crusts are good indicators of land conservation, and the lichen component appears as the most sensitive to disturbances (Graetz & Tongway, 1986). However, in Argentina, most lichenological studies have been devoted almost exclusively to corticolous, saxicolous and foliicolous lichens (e.g. Ruiz, 1991; Adler, 1988, 1992; Scutari, 1992a-b; Estrabou, 1995, 1998; Ferraro, 1997; Calvelo, 1994, 1998b). With the exceptions of regional revisions of particular taxa (e.g. Stenroos *et al.*, 1992; Galloway *et al.*, 1995), little attention was paid to soil-associated species in Argentina. The present work is part of a major study focusing on the use of lichens as bioindicators of rangeland conservation.

### MATERIALS AND METHODS

Specimens were collected at five localities in the surroundings of Puerto Madryn, Chubut, Argentina (two reference sites and three sites under different grazing pressures), and examined using current laboratory techniques. Collection needed very careful and close examination of the soil surface, most times by kneeling down and observing with a hand lens at ground level. For identification of taxa, the main works used were the following: Cengia Sambo (1930); Grassi (1950); Mayrhofer & Poelt (1979); Mayrhofer (1982, 1984); Timpe (1990); Breuss (1993); Eldridge & Tozer (1997); Calvelo & Liberatore (2000); Feuerer (2002). Micrographs were taken with a Zeiss Stemi SV6 stereomicroscope and a Zeiss MC80 camera. All the material is kept in the first author's private herbarium. Some duplicates were deposited in AMNH, ESS and GZU.

## RESULTS AND DISCUSSION

Eight species are reported and these are briefly described and illustrated. Descriptions include the main characters for identification, recognition in the field and differentiation from species of similar appearance.

### New records for South America

***Fulgensia subbracteata*** (Nyl.) Poelt Fig. 1

Thallus crustose-areolate, yellow to yellow-orange, K+ purple, usually on a black hypothallus (visible when wet), areolae disperse, very small, to 0.6-0.8(-1.2) mm in diam., crenate, with marginal granules.

*Remarks*: ***F. subbracteata*** may be readily distinguished in spite of its small size because of the yellow color and the K+ purple reaction. However, in the study area the species is very scarce and uncommon, and in some cases it was not detected until the examination of samples in the laboratory. In Australia's dry country, it is a common species apparently restricted to soils with high content of gypsum and limestone rocks (Eldridge & Tozer, 1997; Eldridge, 1998). In the study area, we found only terricolous-muscicolous, sterile specimens.

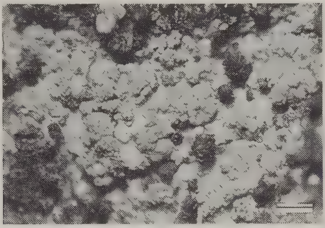

Fig. 1. ***Fulgensia subbracteata*** (herb. Scutari 411A). Scale: 0.5 mm.

**Representative specimens examined**: *Argentina, Prov. Chubut, Depto. Biedma, Ea. Gallastegui*, ruta prov. n° 4, a unos 300 m del cruce con la ruta nac. n° 3, banquina norte, 42° 44'S, 65° 07'W, herb. Scutari 499B. *Ea. El Amparo (Martínez),* 42° 41'S, 65° 38' W, ruta prov. n° 4, 60 km al W de Puerto Madryn, sitio con presión de pastoreo moderada, herb. Scutari 411A-B. *Ea. El Ranchito,* 42° 49' S, 65° 37' W, sobre ruta prov. n° 4, 60 km al W de Puerto Madryn, sitio con presión de pastoreo alta, herb. Scutari 418B, 424C, 430A-B, 436A-B. *Laguna Blanca,* 42° 48' S, 65° 07' W, 120 m snm, ruta nac. 3, ca. 4.5 km al sur de Puerto Madryn, banquina oeste, herb. Scutari 442, 444D, 446, 447B, 454A-B, 456.

### ***Rinodina mucronatula*** Magnusson Fig. 2

Thallus crustose-verrucose, whitish-glaucous, powdery, rarely reduced to almost absent. Apothecia lecanorine, up to 1 mm in diam., discs black, sometimes white-pruinose, plane, spores 8 per ascus, grayish to brownish, ellipsoid, polar-bicellular (*Physcia*-type) with apical appendages. On soil, intermixed with mosses.

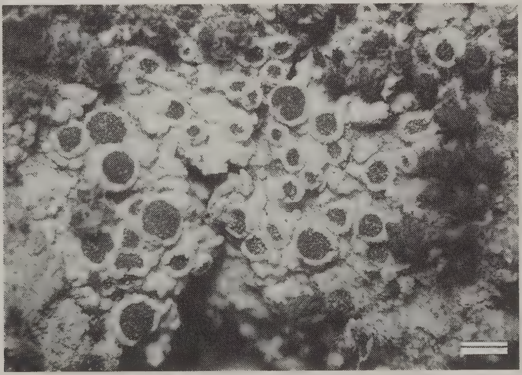

Fig. 2. ***Rinodina mucronatula*** (herb. Scutari 479B). Scale: 1 mm.

*Remarks:* The species was previously known as an arctic-alpine element in Europe, Asia and North America (Timpe, 1990). In the study area, ***Rinodina mucronatula*** appears as a rare to moderately frequent species in scarcely disturbed sites. In spite of forming small patches, it is quite readily seen because of the whitish color. Microscopically, the species is distinguished by the spores with apical appendages.

**Representative specimens examined:** *Argentina, Prov. Chubut, Depto. Biedma, Ea. Gallastegui*, ruta prov. n° 4, a unos 300 m del cruce con la ruta nac. n° 3, banquina norte, 42° 44'S, 65° 07'W, herb. Scutari 479A-B, 483, 486, 488, 498. *Ea. San Luis (Sarasa),* 42° 39' S, 65° 23' W, 115 m snm, sobre ruta prov n° 4, 40 km al W de Puerto Madryn, sitio con presión de pastoreo moderada, herb. Scutari 468, 471A-B. *Laguna Blanca,* 42° 48'S, 65° 07'W, 120 m snm, sobre ruta nac. 3, ca. 4.5 km al sur de Puerto Madryn, banquina oeste, herb. Scutari 505, 507.

## New records for Argentina

***Aspicilia contorta*** (Hoffm.) Krempelh. Figs. 3, 4

Thallus saxicolous or terricolous, areolate, whitish-gray, whitish-green to olivaceous, sometimes variegated, K-, areolae up to 1.0-2.3(-3.4) mm in diam., connected by thick, branched rhizinate strands (terricolous specimens), or with a radiate prothallus (saxicolous spec.). Apothecia immersed, 1 per areole, with one to several openings, discs black, white-pruinose, spores 4 per ascus, colorless, globose, 1-celled.

*Remarks:* ***A. contorta*** exhibits striking morphological differences between saxicolous and terricolous specimens (Table 1; Figs. 3 and 4, respectively), initially thought as belonging to different species. It is quite common in highly grazed sites where it forms conspicuous patches on soil and thus is a potential bioindicator species. The species was previously cited for Bolivia (Feuerer, 2002).

**Representative specimens examined:** *Argentina, Prov. Chubut, Depto. Biedma, Ea. Gallastegui,* 42° 44'S, 65° 07'W, sobre ruta prov. n° 4, a unos 300 m del cruce con la ruta nac. n° 3, banquina norte, sitio de referencia (sin pastoreo desde hace más de 10 años), herb. Scutari 492, 502A-B. *Ea. El Amparo (Martínez),* 42° 41'S, 65° 38'W, sobre ruta prov. n° 4, 60 km al W de Puerto Madryn, sitio con presión de pastoreo moderada, herb. Scutari. 396B, 399C-D, 400B, 404A-B, 406C-D, 409B. *Ea. El Ranchito*, 42° 49' S, 65° 37' W, sobre ruta prov. n° 4, 60 km al W de Puerto Madryn, al lado de clausura, con pastoreo alto. herb. Scutari 420, 421, 430A, 431, 434, 436B, 437B. *Ea. San Luis (Sarasa),* 42° 39'S, 65° 23'W, 115 m snm, sobre ruta prov. n° 4, 40 km al W de Puerto Madryn, sitio con presión de pastoreo baja, herb. Scutari 389C-E. *Laguna Blanca,* 42° 48'S, 65° 07'W, 120 m snm, sobre ruta nac. 3, ca. 4.5 km al sur de Puerto Madryn, banquina oeste, herb. Scutari 442, 444B,D, 445, 446, 448, 449, 453A.

Table 1. ***Aspicilia contorta***, morphological variation according to the substratum.

| | **Saxicolous specimens** | **Terricolous specimens** |
|---|---|---|
| **Areolae** | whitish-green, ± contiguous, usually inflated | whitish-gray, color uniform or variegated with green, crowded, convex (revolute), inflated or flat |
| **Prothallus** | white or blackish, composed by radiate, branched hyphae | not evident |
| **Rhizinate strands** | absent | thick, branched |
| **Hypothallus** | not evident | sometimes evident, above rhizinate strands |
| **Apothecia** | always present | rarely present |

***Catapyrenium squamulosum*** (Ach.) O. Breuss Fig. 5 A, B

Thallus terricolous, orange-, reddish- to dark brown, squamules orbicular to irregularly lobed, discrete, appressed, frequently concave with darker, somewhat elevated margins, up to 2.4-3.6(-4.4) mm in diam., upperside smooth and slightly shiny; upper cortex thick (> 30 µm), well differentiated from the algal layer, paraplectenchymatous, cells 7-15 µm in diam., medulla paraplectenchymatous, lower cortex dark brown, rhizohyphae hyaline, thick (> 4 µm in diam.), branched, forming a dense felt. Perithecia prominent, asci cylindrical, 8-spored, ascospores colorless, ellipsoid, unicellular. Pycnidia not found.

*Remarks:* ***C. squamulosum*** was previously cited for Bolivia (Breuss 1993). In the study area, it is very frequent in sites with high grazing pressures, appearing as a quite resistant species. Because of its scattered, small, squamulose, brownish thallus, it may be overlooked in the field. For differentiation with the other terricolous species with squamulose, brown thallus, see under ***Endocarpon pusillum***.

**Representative specimens examined:** *Argentina, Prov. Chubut, Depto. Biedma, Ea. Gallastegui*, 42° 44'S, 65° 07'W, sobre ruta prov. n° 4, a unos 300 m del cruce con la ruta nac. n° 3, banquina norte, sitio de referencia (sin pastoreo desde hace más de 10 años), herb. Scutari 478B, 490, 503, 504A-B. *Ea. El Amparo (Martínez),* 42° 41'S, 65° 38'W, sobre ruta prov. n° 4, 60 km al W de Puerto Madryn, sitio con presión de pastoreo moderada, herb. Scutari 406B. *Ea. El Ranchito*, 42° 49' S, 65° 37' W, sobre ruta prov. n° 4, 60 km al W de Puerto Madryn, al lado de clausura, sitio con presión de pastoreo alta, herb. Scutari 416A, 417A-B, 422B, 423, 424A, 425A, 426, 429B, 430B, 432A-B, 433A-B, 435, 436A. *Ea. San Luis (Sarasa),* 42° 39' S, 65° 23' W, 115 m snm, sobre ruta prov n° 4, 40 km al W de Puerto Madryn, sitio con presión de pastoreo moderada, herb. Scutari 465A-B, 469B, y baja, herb. Scutari 386, 387. *Laguna Blanca,* 42° 48' S, 65° 07' W, 120 m snm, ruta nac. 3, ca. 4 km al sur de Puerto Madryn, banquina este (antes de la lomada al norte de la laguna), herb. Scutari 518, 524, 525A-B, 533B, 534B,D.

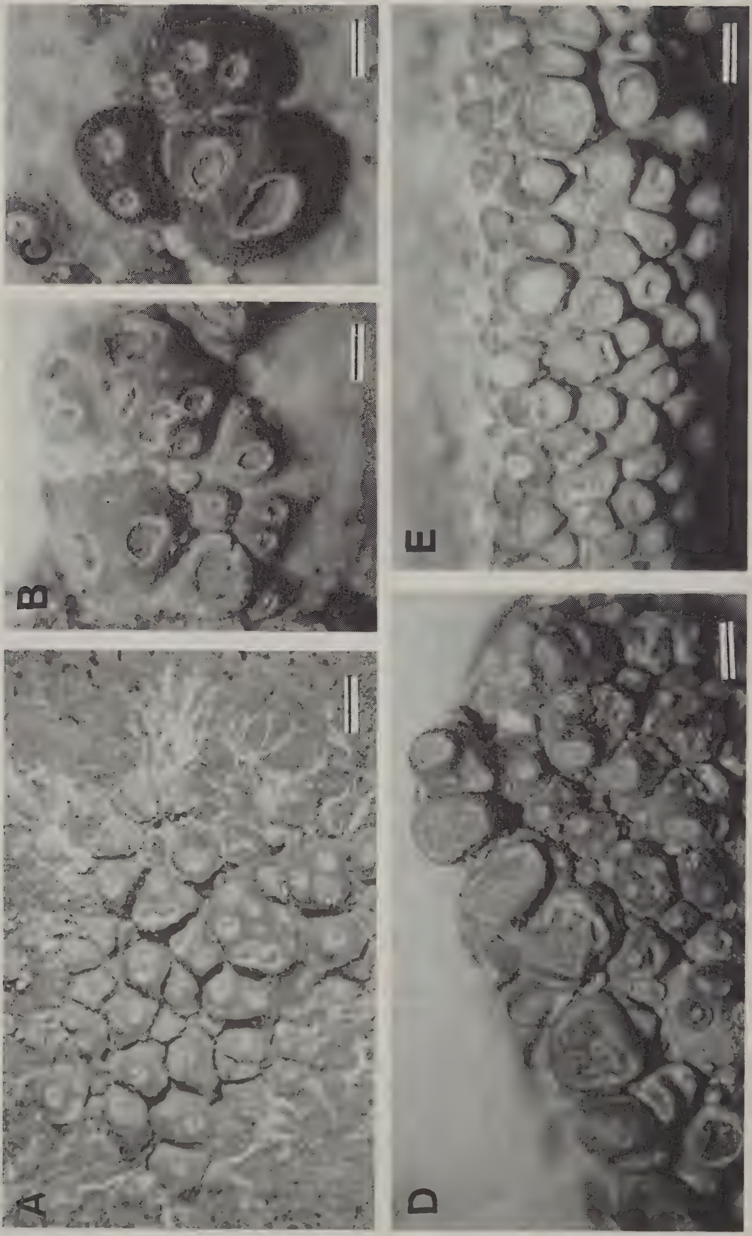

Fig. 3. ***Aspicilia contorta*** on siliceous gravels. A: general view of a young thallus; note the radiate, white prothallus (herb. Scutari 437B). B-C: detail of young apothecia with one to several openings (herb. Scutari 400B). D-E: note the mature apothecia, one per areole (herb. Scutari 389A and 400B, respectively). A-B, D-E = 1 mm; C = 0.5 mm.

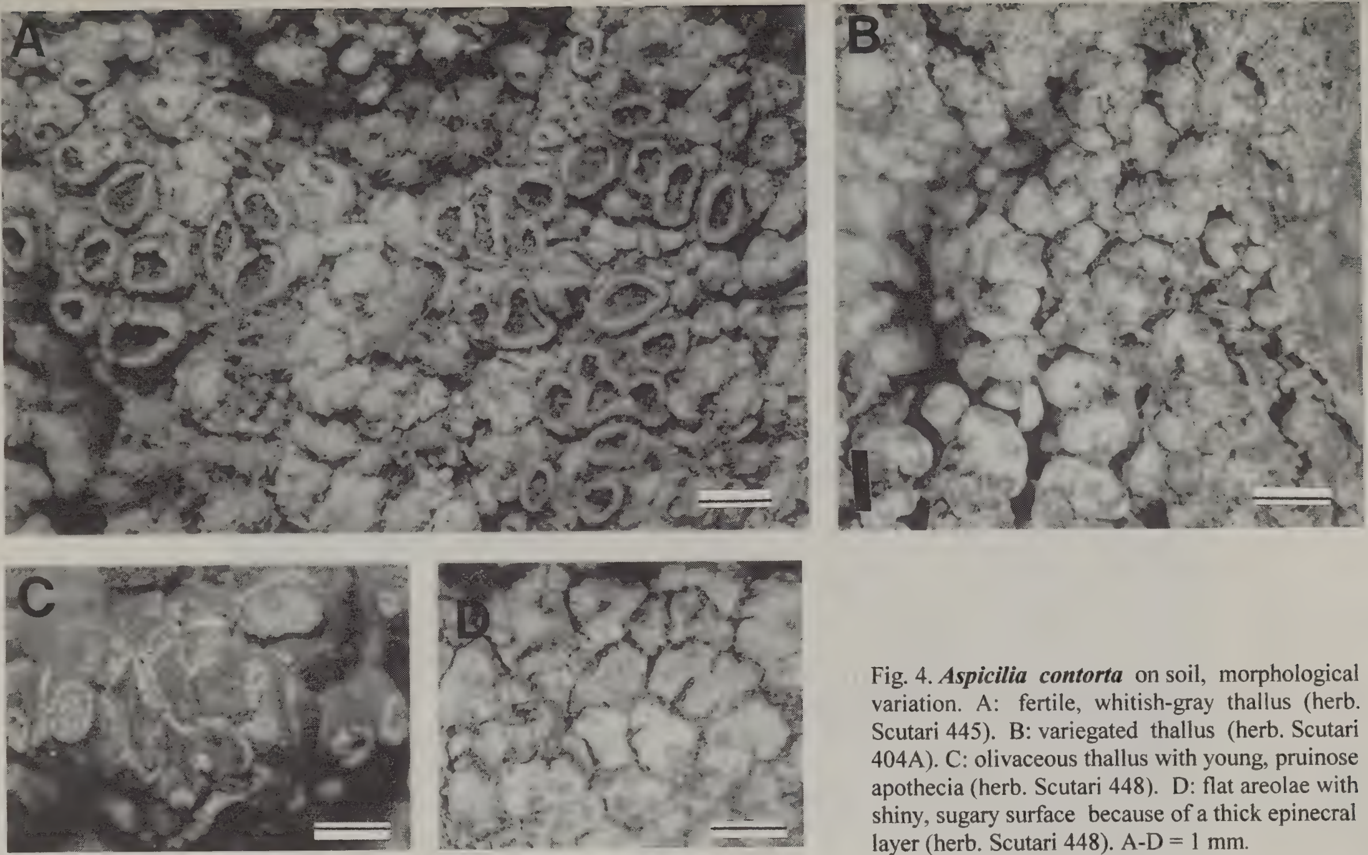

Fig. 4. ***Aspicilia contorta*** on soil, morphological variation. A: fertile, whitish-gray thallus (herb. Scutari 445). B: variegated thallus (herb. Scutari 404A). C: olivaceous thallus with young, pruinose apothecia (herb. Scutari 448). D: flat areolae with shiny, sugary surface because of a thick epinecral layer (herb. Scutari 448). A-D = 1 mm.

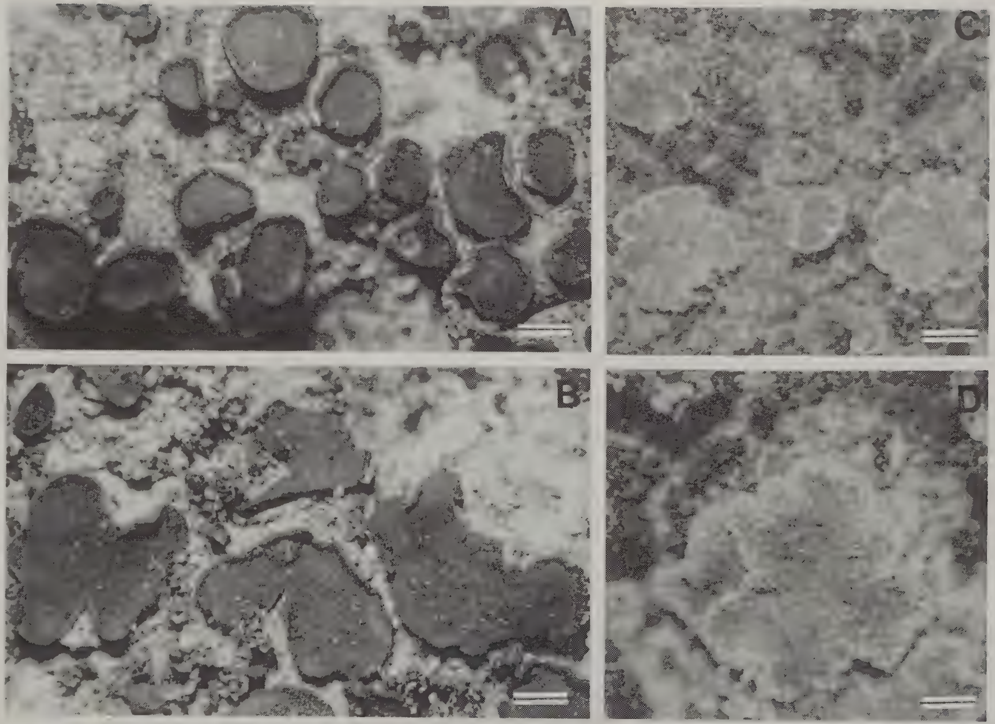

Fig. 5. Terricolous species with squamose, brownish thallus and perithecia. A- B: ***Catapyrenium squamulosum***, fertile squamules. A: small, orbicular squamules (herb. Scutari 429B). B: large, irregularly lobed squamules (herb. Scutari 432B). C-D: ***Endocapon pusillum***, fertile squamules (herb. Scutari 478A). C: general view (moist sample). D: detail of an almost dry squamule. A-C = 1 mm; D = 0.5 mm.

**Lecanora dispersa** (Pers.) Sommerf. Fig. 6

Thallus terricolous, crustose, subareolate, inconspicuous, very similar in color to the substratum when dry, visible only when wet (greenish). Apothecia lecanorine, up to 1.3-1.4 mm in diam., discs brown with white pruina, ascospores 8 per ascus, colorless, ellipsoid, unicellular.

*Remarks:* ***L. dispersa*** is a cosmopolitan species that grows on many substrata. In the study area, it is rare and uncommon. The species was cited previously for Bolivia and Chile (Feuerer 2002).

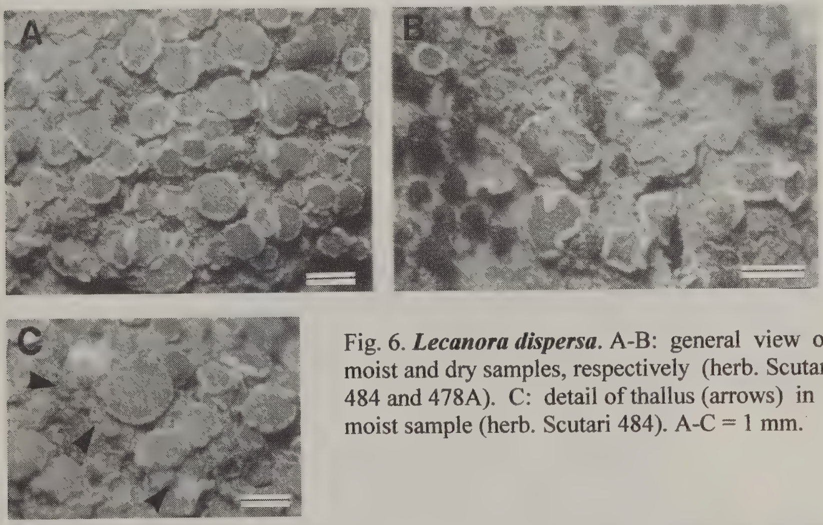

Fig. 6. ***Lecanora dispersa***. A-B: general view of moist and dry samples, respectively (herb. Scutari 484 and 478A). C: detail of thallus (arrows) in a moist sample (herb. Scutari 484). A-C = 1 mm.

**Representative specimens examined**: *Argentina, Prov. Chubut, Depto. Biedma, Ea. Gallastegui*, 42° 44'S, 65° 07'W, sobre ruta prov. n° 4, a unos 300 m del cruce con la ruta nac. n° 3, banquina norte, sitio de referencia (más de 10 años sin pastoreo), herb. Scutari 478A, 484, 499B. *Ea. El Ranchito*, 42° 49' S, 65° 37' W, sobre ruta prov. n° 4, 60 km al W de Puerto Madryn, al lado de clausura, sitio con presión de pastoreo alta, herb. Scutari 424B. *Laguna Blanca,* 42° 48' S, 65° 07' W, 120 m snm, sobre ruta nac. 3, ca. 4.5 km al sur de Puerto Madryn, banquina oeste, herb. Scutari 506, 508, 509A.

**Endocarpon pusillum** Hedw. Fig. 5 C-D

Thallus terricolous, composed by discrete, appressed, grayish-brown, regularly lobed squamules up to 1.2-2.4(-2.9) mm in diam., upperside dull, powdery, margins paler, pruinose, underside with a felt of rhizohyphae. Perithecia usually non-prominent, with hymenial algae, ascospores 2 per ascus, brown, ellipsoid, muriform.

*Remarks:* The presence of this species in Argentina - previously cited by Krempelhuber (1879) with no reference to locality - is confirmed here. In the field, ***Endocarpon pusillum*** is difficult to observe because of its small size and "soil-color". In addition, it may be difficult to distinguish from ***Catapyrenium squamulosum***, the other terricolous species with brown squamules present in the area. The two species can be differentiated by the squamules (smaller, regularly lobed, soft vs. larger, orbicular to irregularly lobed, somewhat coriaceous, respectively), the upper surface (powdery, dull, light brown vs. smooth, slightly shiny, brown with an orange to reddish tinge), and the squamule margins (whitish, coarse-granulose vs. smooth, frequently dark brown to blackish). In Australia, ***E. pusillum*** has been regarded as a pioneer species (Eldridge, 1998). In the study area, it is much less frequent than ***C. squamulosum***, particularly in grazed areas. As a consequence, ***E. pusillum*** is thought to be much more sensitive to grazing disturbance.

**Representative specimens examined:** *Argentina, Prov. Chubut, Depto. Biedma, Ea. Gallastegui,* 42° 44'S, 65° 07'W, sobre ruta prov. n° 4, a unos 300 m del cruce con la ruta nac. n° 3, banquina norte, sitio de referencia (sin pastoreo desde hace más de 10 años), herb. Scutari 478A, 481, 490, 492, 494. *Ea. El Ranchito,* 42° 49'S, 65° 37'W, sobre ruta prov. n° 4, 60 km al W de Puerto Madryn, al lado de clausura, con presión de pastoreo alta, herb. Scutari 418 B, 419, 424B. *Ea. San Luis (Sarasa),* 42° 39'S, 65° 23'W, 115 m snm, sobre ruta prov. n° 4, 40 km al W de Puerto Madryn, sitio con presión de pastoreo baja, herb. Scutari 391A-B.

## New records for Chubut Province

In the course of the study two species were found that have not previously been recorded from Chubut Province.

***Psora decipiens*** (Hedw.) Hoffm. Fig. 7

Thallus terricolous, squamules pink to orange-pink, ±orbicular to irregularly lobed, discrete, appressed, plane to slightly concave, up to (1.7-)2.9-4.5(-9.4) mm in diam., upper surface smooth with thin, waxy plates of epinecral layer, or fissured because of the presence of a thick, white epinecral layer disappearing with age; margins crenulate, white; underside with thin, branched rhizinate strands and felt of rhizohyphae. Apothecia submarginal (laminal but close to the squamule margins), epruinose, lecideine, black, ascospores 8 per ascus, colorless, ellipsoid, unicellular.

*Remarks:* ***Psora decipiens*** had been previously cited for Río Negro Province (Müller Argoviensis, 1889), so that its known distribution area is extended southwards to parallel 42°S. It is the most striking species in the study area, forming conspicuous patches on soil surface. ***P. decipiens*** is characterized by its pinkish, relatively large squamules with black, submarginal apothecia, and appears to be moderately frequent in highly grazed sites. In Australia, it was reported as a common species in limey soils (Eldridge & Tozer, 1997). In the study area, it is a common species with wide distribution and moderate tolerance to disturbances, forms striking patches and exhibits considerable variation in coverage. Because of these features, ***P. decipiens*** is thought as a potential bioindicator/biomonitor species (Skye, 1968; Nimis, 1990). Apparently the colony size of ***P. crenata***, a closely related species, is a good indicator of the period since disturbance (Eldridge & Ferris, 1999).

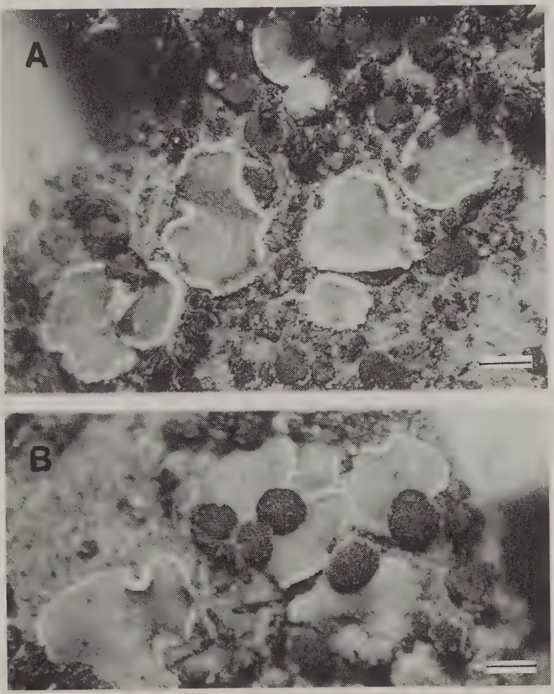

Fig. 7. ***P. decipiens,*** a terricolous species with pink, squamose thallus and lecideine apothecia (herb. Scutari 482). Note the submarginal position of young (A) and mature apothecia (B) A-B: 1 mm.

**Representative specimens examined:** *Argentina, Prov. Chubut, Depto. Biedma, Ea. Gallastegui*, 42° 44'S, 65° 07'W, sobre ruta prov. n° 4, a unos 300 m del cruce con la ruta nac. n° 3, banquina norte, sitio de referencia (sin pastoreo desde hace más de 10 años), herb. Scutari 482, 487, 489, 499A, 500A. *Ea. El Ranchito*, 42° 49'S, 65° 37'W, sobre ruta prov. n° 4, 60 km al W de Puerto Madryn, al lado de clausura, sitio con presión de pastoreo alta, herb. Scutari 422A, 425B, 427, 428, 429C. *Ea. San Luis (Sarasa),* 42° 39'S, 65° 23'W, 115 m snm, sobre ruta prov. n° 4, 40 km al W de Puerto Madryn, sitio con presión de pastoreo baja, herb. Scutari 438. *Laguna Blanca,* 42° 48' S, 65° 07' W, 120 m snm, ruta nac. 3, ca. 4.5 km al sur de Puerto Madryn, banquina oeste, herb. Scutari 447A-C, 451A, 456.

## ***Rinodina bischoffii*** (Hepp.) Massal. Fig. 8

Thallus saxicolous, granulose, whitish. Apothecia lecanorine, very small, up to 0.6-0.8(-0.9) mm in diam., discs convex, black, epruinose, thalline margin very thin, ascospores 8 per ascus, grayish to brownish, ellipsoid, polar-bicellular (*Dubyana-* to *Bischoffii*-type).

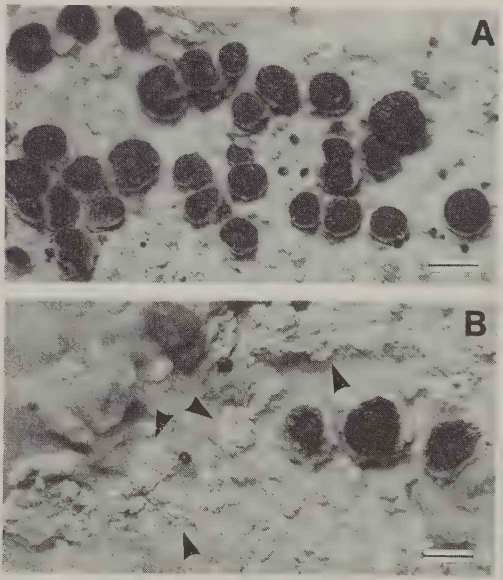

Fig. 8. ***Rinodina bischoffii*** (herb. Scutari 467B). General view (A), and detail of granular thallus (B; arrows) A = 1 mm; B = 0.5 mm.

*Remarks:* ***R. bischoffii*** is an inconspicuous species. It was found mainly in sparingly grazed sites, where it grows only on calcareous gravels together with a ***Sarcogyne*** sp. and a ***Catillaria*** sp. (species also with blackish apothecia). In the field, it is distinguished by the white, granulose thallus and the convex, epruinose apothecial discs.

Previously recorded for Río Negro Province (Müller Argoviensis, 1889), its known distribution area is now extended to parallel 42ºS.

**Representative specimens examined:** *Argentina, Prov. Chubut, Depto. Biedma, Ea. Gallastegui,* 42° 44'S, 65° 07'W, sobre ruta prov. nº 4, a unos 300 m del cruce con la ruta nac. nº 3, banquina norte, sitio de referencia (sin pastoreo desde hace más de 10 años), herb. Scutari 498, 502 A. *Ea. San Luis (Sarasa),* 42° 39'S, 65° 23'W, 115 m snm, sobre ruta prov. nº 4, 40 km al W de Puerto Madryn, sitio con presión de pastoreo moderada, herb. Scutari 459A, 467B. *Laguna Blanca,* 42° 48'S, 65° 07'W, 120 m snm, sobre ruta nac. 3, ca. 4 km al sur de Puerto Madryn, banquina este (antes de la lomada al norte de la Laguna), herb. Scutari 527, 531A, 532A-B, 533A.

## CONCLUSIONS

In spite of being the best collected area of extra-Andean Patagonia, eight new records of soil-associated species from the north-eastern region have been collected at five sites in the surroundings of Puerto Madryn, Chubut Province.

This number of new records illustrates the paucity of current knowledge of the steppe area in South America. Soil-associated species play important ecological roles and are useful tools for monitoring ecosystem conservation, especially since the Patagonian steppe has been (over)grazed for more than a century.

### ACKNOWLEDGEMENTS

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# NEW SPECIES OF THE GENUS RAMALINA (ASCOMYCOTINA: RAMALINACEAE) FROM THE SONORAN DESERT, MEXICO

HIROYUKI KASHIWADANI [1] and THOMAS H. NASH III [2]

1) Department of Botany, National Science Museum, 4-1-1 Amakubo, Tsukuba, Ibaraki 305-0005 Japan E-mail: hkashiwa@kahaku.go.jp

2) Department of Botany, Arizona State University, Tempe, AZ, 85287-1601, USA E-mail: tom.nash@asu.edu

ABSTRACT: Ramalina chihuahuana and R. psoromica from the Sonoran Desert, Mexico are described as new to science.

Key words: *Ramalina chihuahuana, Ramalina psoromica*, lichens

In the course of our taxonomic study of the genus *Ramalina* based on extensive collections from northern Mexico, we found following two new species and provide description herein, *Ramalina chihuahuana* Kashiw. & T.H.Nash and *R. psoromica* Kashiw. & T.H.Nash. *Ramalina chihuahuana* is a saxicolous species found in the high mountains of NW Mexico and is easily recognized by its having soralia and linear pseudocyphellae. *Ramalina psoromica* is a lowland corticolous species similar to *R. usnea*. The new species appear to be endemic to this area.

## Methods

The specimens used for the present study were primarily collected by the authors from northern Mexico and are preserved in the herbaria TNS and ASU. The secondary products of the specimens examined were determined by thin layer chromatography (TLC) using the amended procedures of Culberson & Johnson (1982). To evaluate anatomical variation within the thallus and apothecia, sections were cut by hand with a razor blade. These were mounted in GAW solution and the anatomy and spores were examined with standard light microscopic procedures.

## The species

### **Ramalina chihuahuana Kashiw. & T.H.Nash**, sp. nov. (Fig. 1)

Thallus ut in *Ramalina pollinaria* sed pseudocyphellis linearibus, sorediis marginalibus et acidiis divaricaticis contintinentibus differt.

Type collection. Mexico. Estado de Durango: Sierra Madre Occidental, 47 km W of Durango, E-facing hillside above creek, 23°56′N, 104°57′W, 2215 m, on rocks, 26 May 1992, *H. Kashiwadani* 37324 (TNS holotype; ASU isotype).

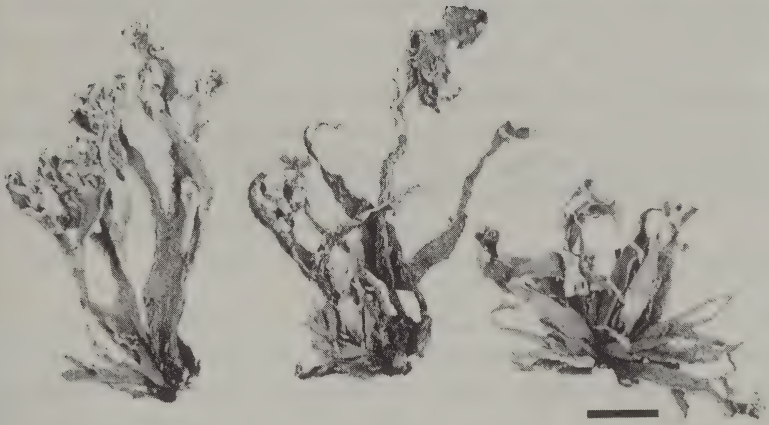
Chemistry (TLC): usnic, divaricatic (major) and 4′-*O*-demethyl-divaricatic acids (minor).

Thallus saxicolous, up to 3 cm long, erect, sparingly branched, growing from a narrow holdfast. Laciniae greenish yellow, solid, 0.3-2(-5) mm wide, flat. Soralia marginal or laminal, often confluent forming continuous decorticated areas especially along lobe margins near the apices; soredia granular, up to 100 $\mu$m in diam. Pseudocyphellae short, linear, flat. Laciniae 100-200 $\mu$m thick; upper cortex continuous, 10-12 $\mu$m thick; chondroid tissue smooth, continuous on upper side, discontinuous on the lower side; medulla loose. Apothecia and pycnidia not seen.

Notes: *Ramalina chihuahuana* closely resembles *R. pollinaria* (West. ex Ach.) Ach. and *R. canariensis* Stein., because all have similar lobes with soralia with granular soredia. However, it can be readily distinguished by the presence of linear pseudocyphellae and by the production of divaricatic acid.

At present, *Ramalina chihuahuana* is known from mountain regions in northern Mexico at elevations between 2000 to 3000 m.

1



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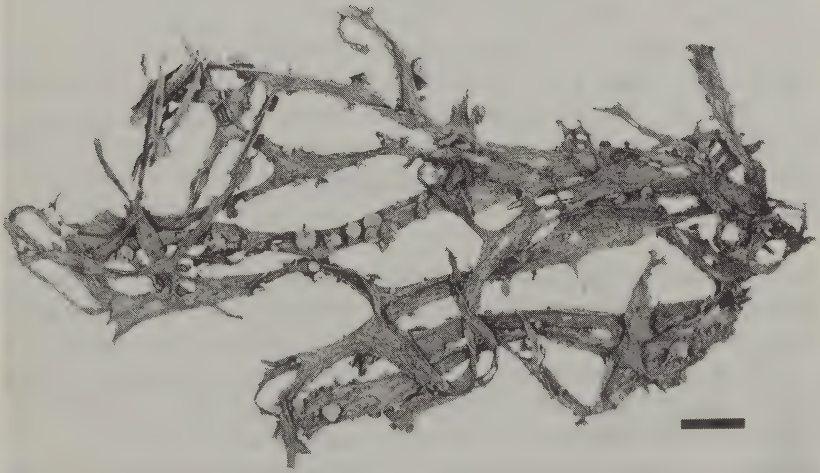

Fig. 1. Holotype of *Ramalina chihuahuana* Kashiw. & T.H.Nash.. Fig. 2. Holotype of *R. psoromica* Kashiw. & T.H.Nash

Specimens examined. Mexico. Type locality, on rocks, *H. Kashiwadani* 37136 (TNS, ASU). Estado de Chihuahua: Sierra Madre Occidental, Tomochic Valley, 22 km W of Tomochic, 28°19´N, 108°01´W, on N facing rock outcrops in a pine-oak forest, 2000 m, 22 May 1992, *H. Kashiwadani* 37299 (TNS, ASU); Sierra Madre Occidental, Cascade de Basseachic, 23°12´N, 108°14´ W, on rock in pine-oak forest above the falls, 1950 m, 22, May 1992, *H. Kashiwadani* 37102c (TNS). Estado de Sinaloa: Sierra Madre Occidental, 1 km S of Barranca Lievre near route 40, 2 km W of the Durango border, 23°28´N, 105°50´W, 2300, on rocks, 27 May 1992, *H. Kashiwadani* 37285 (TNS, ASU).

**Ramalina psoromica Kashiw. & T.H.Nash,** sp. nov. (Fig. 2)

Thallus ut in *Ramalina usnea* sed sporis late fusiformibus et acidiis proromicaticis contintinentibus differt.

Type collection. Mexico. Estado de Sinaloa: 1.7 km S of La Reforma, 25°06´N, 108°02´W, 10 m, on *Fouqueria* in coastal thorn forest, 27 November, 1975, *T.H. Nash* 12303 (ASU holotype; TNS isotype).

Chemistry (TLC): usnic and psoromic acids.

Thallus corticolous, up to 20 cm long, pendulous, sparingly branched, growing from a narrow holdfast. Laciniae greenish yellow, solid, up to 5(-10) mm wide, flat. Soralia absent. Pseudocyphellae linear, flat. Laciniae 150-300 $\mu$m thick; cortex indistinct, 10-12 $\mu$m thick; chondroid tissue smooth, discontinuous; medulla loose. Apothecia common, marginal or submarginal; disc without white margin; thalloid exciple pseudocyphellate; ascospores broadly ellipsoid, 14-16 x 4.8-5.6 $\mu$m . Pycnidia not seen.

Notes: *Ramalina psoromica* might be confused with *R. usnea*, a species common from southeastern North America to South America as both have similar pendulous branches with linear pseudocyphellae. However, it can be distinguished from the latter by the smooth chondroid tissue (Kashiwadani & Kalb, 1993) and the broadly ellipsoid spores. In addition it produces psoromic acid which is completely absent in *R. usnea*. It also resembles *R. chilena* (Nyl.) Kashiw., an endemic species of Chile, which differs in having smaller and longly fusiform spores (12-14 x 3-3.5 $\mu$m in size) and in producing sekikaic acid.

At present this species is only known from a restricted area of Sinaloa.

Specimens examined. Mexico. Sinaloa: Boca del Rio, 30 km S of Guasare, area behind 3.3 km SSW of El Gato, 25°06´N,108°02 ´W, 27 Nov. 1975, *T.H. Nash* 12280 & 12284 (ASU); 1.7 km S of La Reforma, 25°06´N,108°02´W, 3 m, on *Fouqueria* in coastal thorn forest, *T.H. Nash* 18304 (ASU).

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# LICHENOPELTELLA HETERODERMIICOLA, A NEW LICHENICOLOUS ASCOMYCETE ON HETERODERMIA SPECIOSA IN ARKANSAS

**Mariette S. COLE**[1] **and David L. HAWKSWORTH**[2]

[1]3010 West 112th St., Bloomington MN 55431-3815, USA;
e-mail: mscole@mn.rr.com

[2]Departamento de Biología Vegetal II, Facultad de Farmacia, Universidad
Complutense, Plaza de Ramón y Cajal, Ciudad Universitaria, E-28040
Madrid, Spain; e-mail: myconova@terra.es

**Abstract**: The new lichenicolous ascomycete, *Lichenopeltella guttata* was discovered on *Heterodermia speciosa* from Arkansas, USA. The new species has catathecioid ascomata lacking ostiolar setae and 8-spored asci apparently lacking setulae.

**Keywords**: Lichens, fungi, commensal, USA

## INTRODUCTION

The genus *Lichenopeltella* includes lichenicolous species of ascomycetes with catathecioid ascomata (Matzer, 1996). The taxonomy at the generic level of the ascomycetes with catathecioid ascomata in the family *Microthyriaceae* has been in a state of flux over the years, and the names *Actinopeltis, Micropeltopsis,* and *Trichothyrina* are encountered in the older literature when these lichenicolous ascomycetes are being discussed. The confusion results from the uncertainty of the taxonomic value of the characters used to delimit the genera. The presence and disposition of ostiolar setae on the ascomata have been used as generic characters. For example, Ellis (1977) separated *Trichothyrina* from *Actinopeltis* based on the presence of ostiolar setae displayed outwards in *Actinopeltis*, those either being absent or small and convergent in *Trichothyrina*. *Micropeltopsis* was applied by Vainio (1921) to lichenicolous ascomycetes with catathecioid ascomata, the type of the genus, *M. cetrariicola*, lacking ostiolar setae. However, *Lichenopeltella* had been introduced already by Höhnel (1919) for lichenicolous ascomycetes with catathecioid ascomata so *Micropeltopsis* was considered a synomym of *Lichenopeltella* by Santesson (1989, 1991). Anamorphs are not yet known for these fungi, hindering resolving the relationships between the lichenicolous *Lichenopeltella* species and similar fungi growing on vascular plants, mostly in the tropics, still placed in the genera *Trichothyrina* and *Actinopeltis* (e.g. Spooner and Kirk, 1990) that need definitive study.

To date, 26 species of *Lichenopeltella* have been described from a wide variety of lichens and other substrates in both temperate and tropical areas (Aptroot *et al.*, 1997; Earland-Bennett & Hawksworth, 1999; Etayo & Diederich, 1996; Hansen & Alstrup, 1995; Hariharan *et al.*, 1996; Hawksworth, 1980, 1982; Jones & Hawksworth, 2001; Matzer, 1996; Molitor & Diederich, 1997; Santesson, 1989, 2001). In the course of our studies of the lichenicolous fungi of the USA, a new species of *Lichenopeltella* was discovered on *Heterodermia speciosa* from Arkansas.

## METHODS

The specimen was studied macroscopically with a Nikon stereomicroscope with an eyepiece reticule at magnifications ranging up to 80 x. Microscopic characters were studied using hand-made sections or squash preparations with an Olympus BH2 microscope equipped with Nomarski differential interference contrast optics. The specimen was mounted in water. Drawings were made using a drawing tube giving a 3200 x magnification. Average means of features measured are placed in parenthesis in italic type.

## TAXONOMY

**Lichenopeltella heterodermiicola** M.S. Cole & D. Hawksw. **sp.nov.**
Figs 1-2

Ascomata catathecia, superficialia, atrobrunnea val nigra, laxe aggregata80-(*102*)-130 µm diam, ostiolata setis nullis; paries superior cellulis radiatis serialibus, polihedricis, 4-(*4.5*)-5.5 x 2.5-(*3*)-5 µm; ostiolum cellulis obscures pigmentatis circumdatum. Asci late clavati, 41-(*43.5*)-46 x 12-(*13*)-14 µm, 8-spori. Ascosporae oblongo-ellipsoideae ad soleiformes, 1-septatae, ciliis non vidis, 13-(*13.5*)-14.5 x 3.5-(*4*)-5 µm.

Holotypus: USA: Arkansas: Newton County, Ozark National Forest, Upper Buffalo Wilderness Area, above Buffalo River near southwest corner of wilderness, on north facing hillside with *Quercus* spp., *Carya*, and *Acer rubrum*, 35°49'13" N, 93°27'06" W, elevation 533 meters, on thallus of *Heterodermia speciosa* growing on *Carya* sp., 29 May 2000, *C. Wetmore 85001* (MIN).

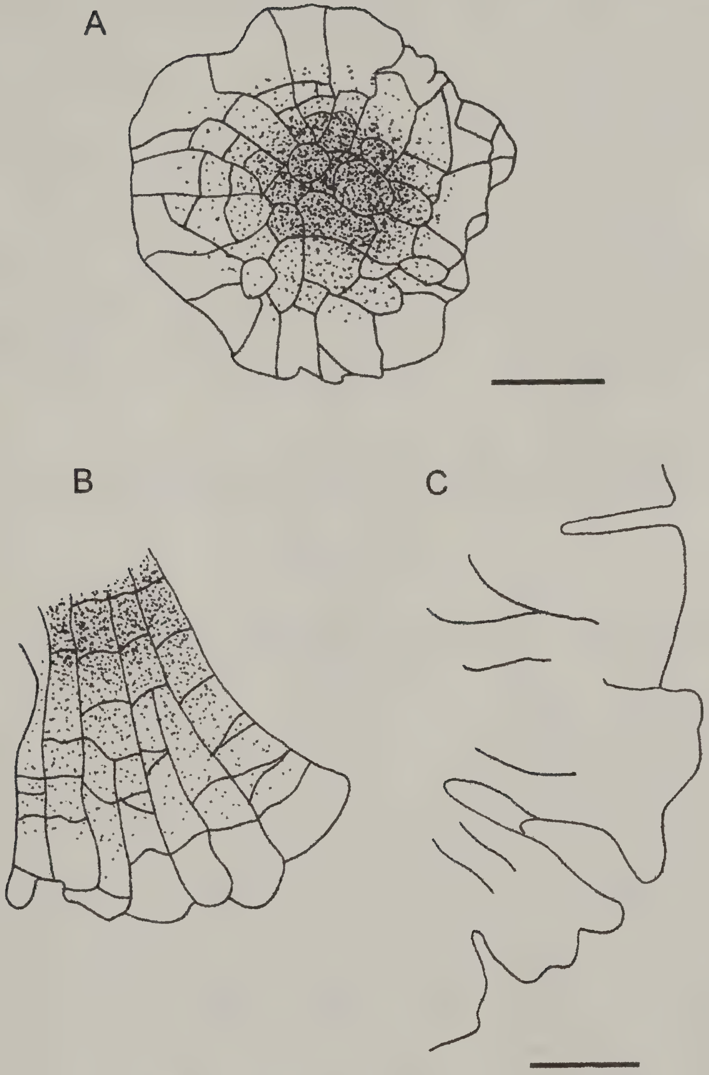

**Figure 1.** *Lichenopeltella heterodermiicola* (*Wetmore* 85001, MIN-holotype). A, Developing plate. B, Outer edge of upper, mature plate. C, Outline of outer edge of lower plate. Scale = 10 µm.

*Ascomata* catathecioid, superficial, dark brown to black, tending to grow in clusters, orbicular, 80-(*102*)-130 µm diam, smaller when crowded (48-(*64*)-80 µm), 32-(48)-80 µm high, consisting of two layers, the lower light brown with elongate cells creating a crenate border, cells 11-(*15*)-20 µm towards the edge, the bottom layer held to the top layer by brown hyphae, the upper layer dark brown, with polyhedral cells 4-(*4.5*)-5.5 x 2.5-(3)-5 µm, rising to form an inverted cone on the lichen surface in which the asci are found, ostiolate, non-setose, the ostiolar aperture 18.5-(*21*)-28 µm diam, surrounded by dark cells, 4-(*5*)-6.5 x 4-(*4*)-5 µm. *Haemathecium* not observed. *Asci* 8-spored, with walls laterally 1.5 µm thick, broadly clavate, 41-(*43.5*)-46 x 12-(*13*)-14 µm, bitunicate in structure, with an internal apical beak, discharge fissitunicate, tholus negative in Lugol's iodine solution with 10% KOH pre-treatment. *Ascospores* oblong ellipsoid to soliform, rounded at the apex, 1-septate, not constricted at the septum, hyaline, smooth-walled, setulae not seen, containing 1-4 large oil droplets at maturity, 13-(*13.5*)-14.5 x 3.5-(*4*)-5 µm.

*Host*: *Lichenopeltella heterodermiicola* is commensalistic on the thallus of *Heterodermia speciosa*, causing no discolouration or deformity of its host.

## DISCUSSION

This new fungus belongs to the group of *Lichenopeltella* species that lack ostiolar setae, as do most described species (e.g. *L. cetrariicola*, *L. cladoniarum*, *L. coppinsii*, *L. epiphylla*, *L.heterodermiae*, *L. hydrophila*, *L hypogymniae*, *L. hypotrachynae*, *L. leptogiae*, *L. maculans*, *L.megalosporae*, *L. microspora*, *L. minuta*, *L. physciae*, *L. pseudocyphellariae*, *L. ramalinae*, *L.thamnoliae*, and *L. thelidii*; see Aptroot et.al., 1997). *Lichenopeltella* species appear to be largely host specific (Earland-Bennett & Hawksworth, 1999), but *L. heterodermiicola* differs markedly from the one species known on *Heterodermia*, *L. heterodermiae*. *L. heterodermiae*, described from *H.* sp. in Papua New Guinea and also found on *H. leucomelos* and *H.* cf. *obscurata* (Aptroot et al., 1997), has longer asci (71-81 x 11.5-14 µm) which are 4-spored, and the spores are larger (24-28 x 7.5-8.5 µm) and have one pair of setulae; the ascomata are also significantly larger (150-250 µm). Other species that are similar to *L. heterodermiicola* but do not share the host genus include *L. cladoniarum*, *L. coppinsii*, *L maculans*, and *L. thelidii*. *L. cladoniarum* has smaller ascomata (50-70 µm) and larger spores (18-21 x 5-6 µm) (Hansen & Alstrup, 1995). *L. coppinsii* has larger asci (45-66 x 14.5-16 µm) and ascospores with varying numbers of septae (0-3) and 2-4-(5) setulae (Earland-Bennett & Hawksworth, 1999). *L. maculans* has longer and narrower asci (53-60 x 8-13 µm) and smaller spores (10.5-14 x 3-4 µm)

(Höhnel, 1919). Finally, *L. thelidii* has shorter asci (23-31 x 10.5-16 µm) and less oblong spores (11.5-12.5 x 5-5.5 µm) with 3 pairs of lateral setulae (Molitor & Diederich, 1997).

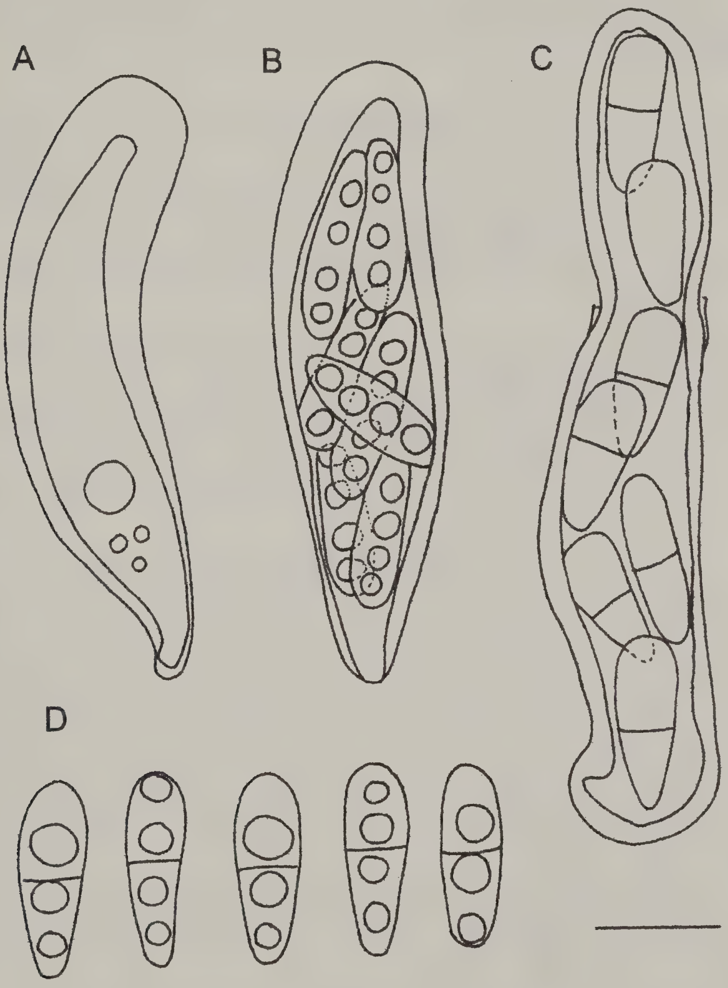

**Figure 2**. *Lichenopeltella heterodermiicola* (*Wetmore* 85001, MIN-holotype) A, Immature ascus. B, Mature ascus. C, Ascus releasing spores. D, Spores. Scale = 10 µm.

## ACKNOWLEDGEMENTS

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MYCOTAXON

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# BHARATHEEYA, A NEW HYPHOMYCETE GENUS FROM INDIA

MARIA D'SOUZA & D. J. BHAT*
Department of Botany, Goa University, Goa-403 206, India
*djbhat@unigoa.ernet.in

**ABSTRACT** A new genus of the dematiaceous hyphomycetes, *Bharatheeya,* is proposed for *Spadicoides goanensis* on the basis of its production of solitary, distoseptate conidia on non-cicatrized polytretic, verrucose conidiogenous cells and mononematous conidiophores. In addition, *Bharatheeya mucoidea* anam. sp. nov. isolated from decaying leaves of *Calamus thwaitesii*. is described from the forests of Western Ghats in Goa, India.

**KEY WORDS:** *B. goanensis, B. mucoidea,* litter fungi, taxonomy, India

## INTRODUCTION

Sinclair, Eiker and Bhat (1985), in a reassessment of the genera *Spadicoides* S. J. Hughes (1958) and *Diplococcium* Grove (1885), rejected the branching of conidiophores as a diagnostic generic character and separated the two taxa only on the basis of their respectively solitary or catenate and euseptate conidia. The generic descriptions were emended accordingly Kuthubutheen and Nawawi (1991) reviewed the taxonomy of *Spadicoides* and provided a key to then accepted 16 species. While describing a new dematiaceous hyphomycete, isolated from decaying leaves, producing a solitary conidium on partly verrucose conidiophores with non-cicatrized monotretic conidiogenous cells in the genus *Spadicoides*, as *S. goanensis* Bhat & Kendrick (1993), the authors wrote "*S. goanensis* differs from all other species of *Spadicoides* in (1) its partly verrucose conidiophores, (2) the presence of only one, monotretic conidiogenous cell on each conidiophore, and (3) the production of only a single conidium by the conidiogenous cell".

Cultures from a recent collection of *S. goanensis* gathered from the type locality in Goa, India, revealed a hitherto unknown feature of the fungus, namely production of several solitary, 3-distoseptate, conidia on non-cicatrized polytretic conidiogenous cells. This, along with recovery of a so far unknown fungus with similar conidiogenesis, 2-4-distoseptate conidia with a mucoid apical cap and otherwise similar characters warranted redescription of *S. goanensis*, its redisposition along with the new fungus in a new genus *Bharatheeya* and a detailed review of similar genera.

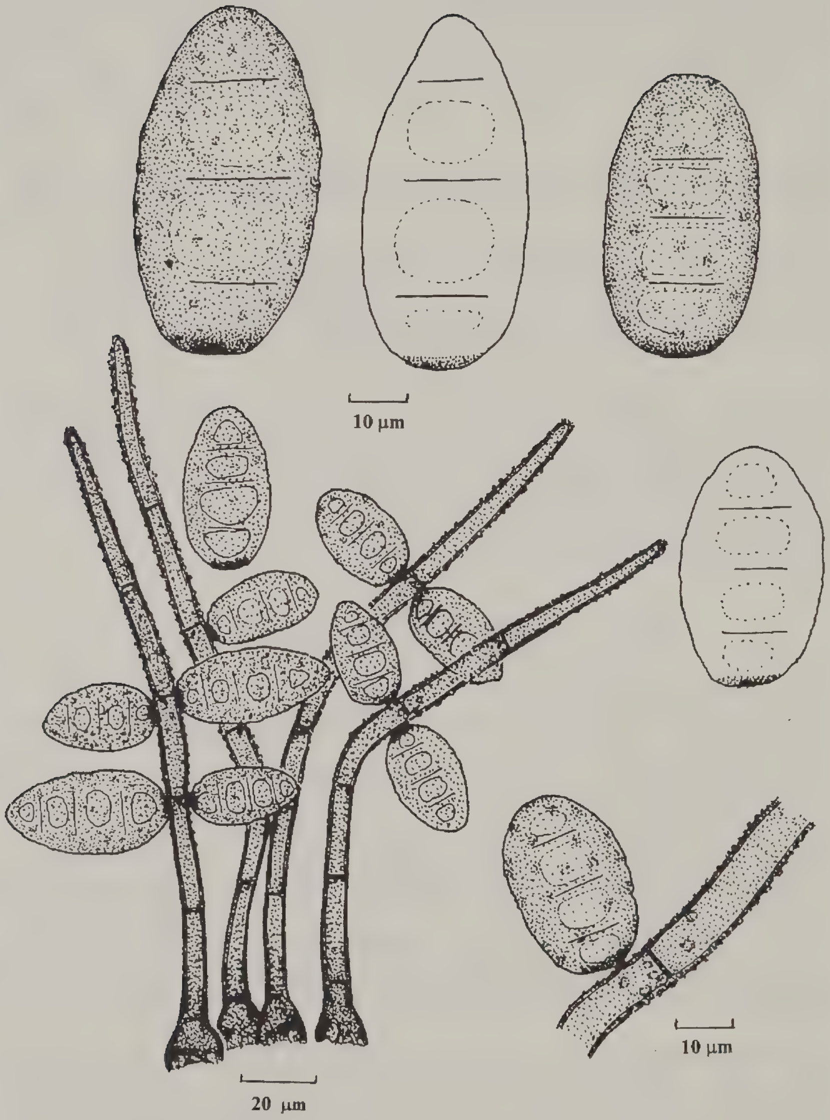
10 µm
10 µm
20 µm

Fig 1. *Bharatheeya goanensis*: Conidiophores and conidia.

## TAXONOMIC DESCRIPTION

*Bharatheeya* **anam. gen. nov.** (Fig.1,3-5)
[Etymology: *Bharath* in Sanskrit ancient name for India]

Ad fungos conidiales, hyphomycetes, pertinens. Coloniae effusae, olivaceae vel atro-brunneae, hypophyllae. Mycelium partim immersum et partim superficiale, ex hyphis laevis, septatis, ramosis, compositus. Conidiophora mononematica, discreta, aggregata, recta, curvata vel flexuousa, crassitunicata, septata, nonramosa, laevia vel verrucosa, ad basim lobata et inflata, atro-brunnea; versus apicem pallescentia, rotundata. Cellulae conidiogenae intercalares, intergratae, polytreticae, poro pluro, minuto, noncicatrizi, simplici, infra septum superius praeditae. Conidia sicca, solitaria, dry, cylindrico-ovoidea vel clavata, distoseptata, lumine reducto, crassitunicata, laevia vel verrucosa, brunnea vel atrobrunnea.

Conidial fungi, hyphomycetes. Colonies effuse, olivaceous to dark brown, hypophyllous. Mycelium partly immersed, partly superficial, composed of smooth, septate, branched, hyphae. Conidiophores mononematous, discrete, arising singly or in groups, erect, curved to flexuous, thick-walled, unbranched, septate, smooth or verrucose, dark brown, 3-4-lobed and slightly inflated at the base, rounded and slightly paler at the tip. Conidiogenous cells intercalary, integrated, polytretic, with several, simple, non-cicatrized pores below the septa. Conidia dry, solitary, cylindrical-ovoid to clavate, thick-walled, distoseptate, with reduced lumen, smooth to rough-walled, medium to moderately dark brown.

**Type species:** *Bharatheeya goanensis* (Bhat & Kendrick) D'Souza & Bhat, **comb. nov.**
= *Spadicoides goanensis* Bhat et Kendrick *Mycotaxon* **49**: 66-68.1993 (basionym)

Colonies on natural substrate gregarious, olivaceous to dark brown, hypophyllous, on MEA moderately fast growing, slightly floccose on the surface, white to slightly greenish, with circular margin, attaining 10 mm diam. in 7 days. Mycelium partly immersed, partly superficial, composed of smooth, septate, branched, hyaline hyphae 2.5-4 µm wide. Conidiophores mononematous arising in groups of 6-18, erect, curved in the middle, thick-walled, 3-5-septate, unbranched, 160-200µm long, 4-8-lobed and inflated at the up to 15 µm wide base, 6-8.5 µm wide above, lower half smooth to faintly verruculose, above half distinctly verrucose, dark brown and rounded at tips and slightly paler towards the apex. Conidiogenous cells intercalary, intergrated, polytretic, with several (1-5) minute, non cicatrized, simple pores just below the septum, 25-32 x 6-8.5 µm, smooth to verrucose, dark brown. Conidia dry, solitary, more than one, cylindrical-ovoid to clavate, 3-distoseptate, central two cells thick-walled with reduced lumen, verrucose, medium to moderately dark brown, darker at the base, 23-40 x 14-22 µm.

SPECIMEN EXAMINED: (i) On dead and decaying leaves, Morphirla, Goa, India, 28.7.1991, D.J. Bhat, Herb. DJB/GU/No. 514 (Part of Holotype No. DAOM 214612). (ii) On dead and decaying leaves of *Saraca asoca* (Roxb.) Dc Wilde., Bondla Wildlife Sanctuary, Goa, India, 11-2-1998, Maria D'Souza, GUFCC No. 206. (iii) Dried culture mat of the fungus derived on endophytic isolation from fresh leaves of *S. asoca*, Bondla Wildlife Sanctuary, Goa, India, 11-2-1998, Maria D'Souza, GUFCC No. 210.

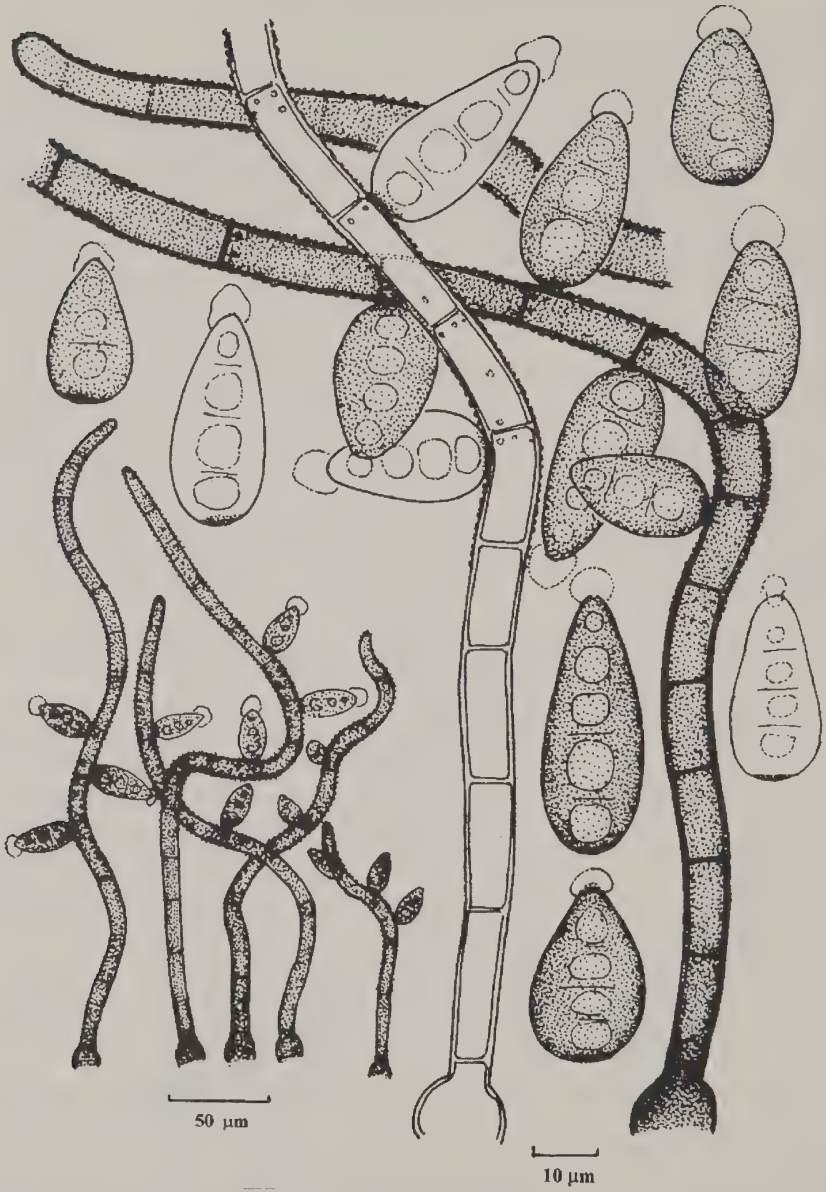

Fig 2. *Bharatheeya mucoidea*: Conidiophores and conidia.

*Bharatheeya mucoidea* D'Souza & Bhat **anam. sp. nov.** (Fig. 2,6-8)

Coloniae effusae, gregariae, olivaceae vel brunneae, hypophyllae. Conidiophora mononematica, discreta, 6-15 aggregata, erecta, medio curvata vel cincinata, crassitunicata, atrobrunnea, 10-18-septata, non-ramosa, 240-370 μm alt., ad inflatus basim 6-12 μm lat., supra 7-10 μm lat., verrucosa, versus apicem pallescentia, leviea vel verrucosa, rotundata. Cellulae conidiogenae intercalares, integratae, atrobrunneae, polytreticae, poro numero, indistincto, minuto, simplici, infra septum superius praeditae. Conidia sicca, solitaria, pyriforma vel clavata, 2-4-distoseptata, crassitunicatis, lumine reducto, leviea, brunnea vel atrobrunnea, 22-40 μm longa, medio 10-18 μm lat. crassa, 4-8 μm lat. basa, versus conspicuosa, crassa, hyalina, mucoidea ad apicem, usque ad 10 μm diam.

Colonies on natural substrate effuse to gregarious, greyish to brown, hypophyllous, on MEA moderately growing, attaining a diam. of 15 mm in 7 days, with rhizoidal margin, raised, grayish white, cottony, velvety, producing conidiophores in concentric rings, reverse of the colony off-white. Mycelium partly immersed, partly superficial, composed of smooth, septate, branched, hyaline hyphae 2.5-3.5 μm wide. Conidiophores mononematous, arising in groups of 6-15, erect, curved to curled in the middle, thick-walled, dark brown, 10-18-septate, unbranched, 240-370 μm long, 6-12 μm wide at the inflated base, 7-10 μm wide above, rounded and slightly paler at the tip, smooth to faintly verrucose in the lower half, distinctly verrucose in the upper half. Conidiogenous cells intercalary, intergrated, dark brown, verrucose, polytretic, with more than one, distinct, minute, non-cicatrized, simple, pores below the septum. Conidia dry, solitary, pyriform to clavate, 2-4-distoseptate, thick-walled, with reduced lumen, smooth, medium to dark brown, 22-40 μm long, 10-18 μm wide in the middle, 4-8 μm wide at the base, with a conspicuous, thick, hyaline, up to 10 μm diam. mucilaginous cap at the tip.

HOLOTYPE, On dry leaves of *Calamus thwaitesii* Becc. Bondla Wildlife Sanctuary, Goa, India, 8 June 1999, Maria D'Souza, GUFCC No. 209. Additional specimen examined: Dried culture mat of the fungus derived as endophytic isolate from fresh leaves of *C. thwaitesii* Becc., Bondla Wildlife Sanctuary, Goa, India, 8.6.1999, Maria D'Souza, GUFCC No. 215

*B. mucoidea* differs from the type species, by its pyriform to clavate, smooth, conidia, each with a conspicuous, colourless, thick, mucilaginous cap at the tip. Both *B. goanensis* and *B. mucoidea* occur as endophytes in fresh leaves and as epiphytes on dead and decaying leaves.

## DISCUSSION

Besides *Spadicoides* and *Diplococcium,* several genera such as *Hemicorynespora* M.B. Ellis (1972), *Monotretomyces* Morgan-Jones et al. (1987), *Polytretophora* Mercado (1983) and *Nusia* Subramanian (1997) were considered as possible repository for these fungi. In *Hemicorynespora*, typified by *H. deightonii* M.B. Ellis, limoniform, species produce solitary, 0-1-euseptate conidia are on percurrently proliferating conidiophores with cicatrized, apical monotretic condiogenous cells. In *Nusia*, typified by *N. scheeleae* Subramanian, species produce solitary, 9-14-euseptate, conidia on mononematous conidiophores with apical monotretic conidiogenous cells. In *Monotretomyces*, typified

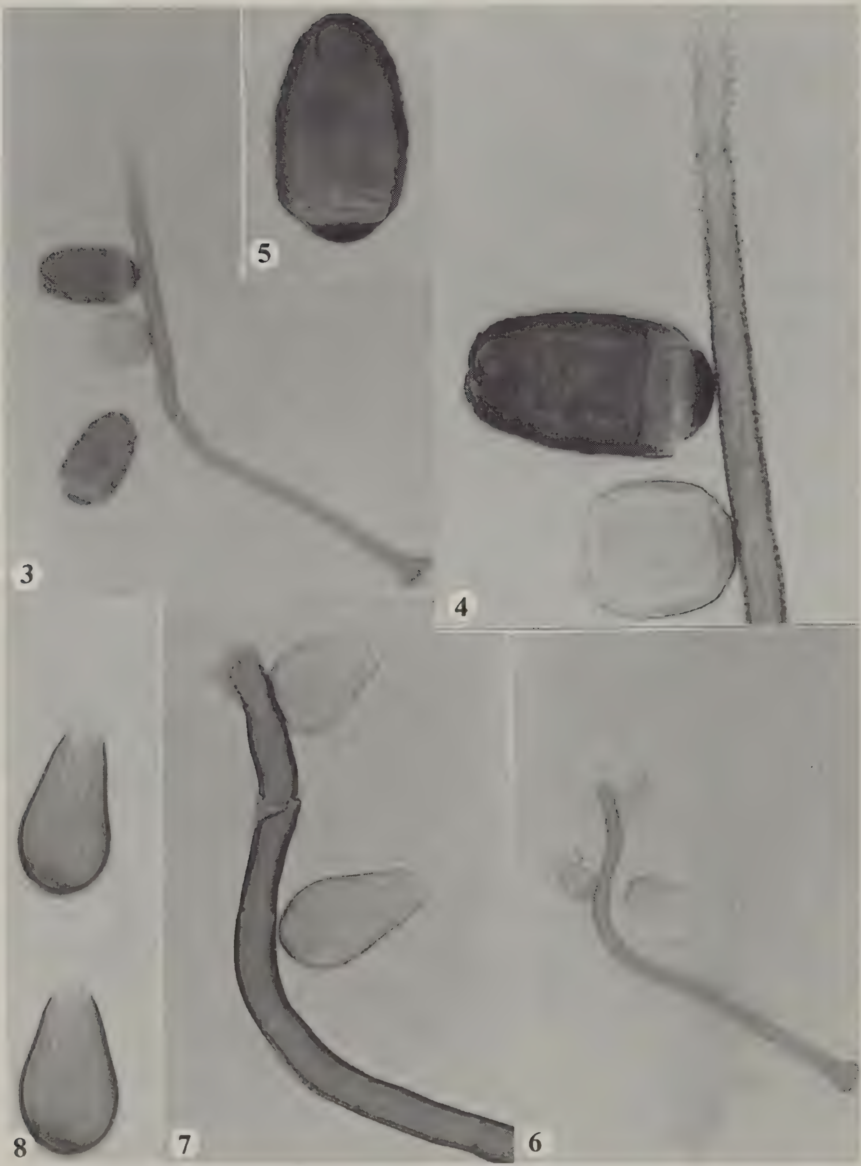

Fig 3-5. *Bharatheeya goanensis*: Conidiophores and conidia.
Fig 6-8. *Bharatheeya mucoidea*: Conidiophores and conidia.

by *M. uniseptatum* Morgan-Jones, Sinclair and Eiker, species produce 1-euseptate, catenate conidia on caespitose conidiophores with terminal, non-cicatrized, monotretic conidiogenous cells. In *Polytretophora,* typified by *P. calcarata* Mercado, species produce solitary, reniform to ellipsoidal, 1-euseptate, conidia on polytretic, non-cicatrized, terminal and intercalary conidiogenous cells on mononematous conidiophores. However, in species of the new genus *Bharatheeya*, 3-4-distoseptate conidia are produced on mononematous, partially verrucose conidiophores with non-cicatrized, polytretic and integrated conidiogenous cells.

The taxonomic significance of euseptate and distoseptate conidia and their usefulness for the delimitation of hyphomycete genera were emphasized by Holubova-Jechova (1990). The combination of characters such as production of distoseptate conidia on non-cicatrized, polytretic, integrated, intercalary conidiogenous cells on verrucose conidiophores exhibited in *Bharatheeya,* stand distinct from the *Spadicoides-Diplococcium* complex and other similar genera discussed above.

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# A NEW SPECIES OF PHALANGISPORA FROM INDIA

KESHAVA PRASAD, T.S. & D. J. BHAT*
Department of Botany, Goa University, Goa-403 206, India
*djbhat@unigoa.ernet.in

**ABSTRACT** A new dematiaceous setose, sporodochial hyphomycete, *Phalangispora bharathensis*, producing unicellular conidia connected by narrow isthmi in branched chains on polyblastic discrete conidiogenous cells, isolated from decaying leaves of *Holigarna arnotiana* (Wt. & Arn.) Hook.f. (F. Anacardiaceae) is described from the forests of Western Ghats in southern India.

**KEY WORDS:** Hyphomycetes, taxonomy

## INTRODUCTION

During studies on the taxonomy and diversity of microfungi of the forests of Western Ghats in southern India, an interesting setose, sporodochial hyphomycete producing hyaline, smooth, unicellular conidia connected by narrow isthmi in branched chains on polyblastic discrete conidiogenous cells and short, thin-walled, hyaline, septate, conidiophores was isolated from fallen and decaying leaves of *Holigarna arnotiana* (Wt. & Arn.) Hook.f. (F. Anacardiaceae) collected from Cotigao Wildlife Sanctuary in Goa State, India and incubated in sterile moist chamber in the laboratory for about two weeks. The fungus is described here as a new species of the genus *Phalangispora* Nawawi & Webster (1982).

## TAXONOMIC PART

*Phalangispora bharathensis* Keshava Prasad et Bhat **sp. nov.** (Fig.1, a-d)
[Etym: Bharath = India]

*Coloniae* effusae, olivaceae ad atrobrunneae. *Mycelium* partim superficiale, partim immersum, ex hyphis septatis, ramosis, hyalinis vel pallide brunneis 2.5-3.5 µm lat. compositum. *Conidiomata* sporodochia, solitaria, pulvinata, 8-16 setas basim ferentia. *Setae* subulatae, apice acutae, septatae, crassitunicatae, atrobrunneae, laeves, ex strato conidiophorum protrudentes, 300-400 x 7-10µm. *Conidiophora* mononematosa, erecta, dwarfa, septata, ramosa in supra, hyalina, 15-30µm longa, 2-4.5 µm lat. *Cellulae conidiogenae* polyblasticae, discretae, terminalis ad ramosis fertilis, denticulatae ad apicem spherical. *Conidia* hyalina, laevia, aseptata, catenata, plerumque

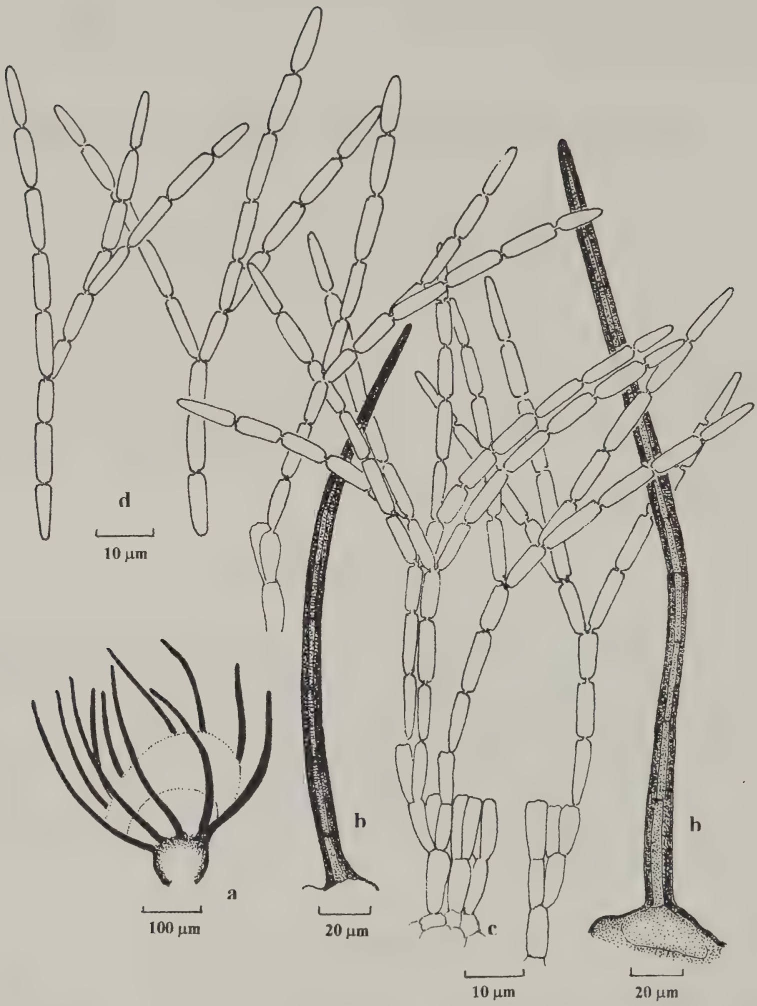

Fig. 1. *Phalangispora bharathensis:* **a.** Entire sporodochium, **b.** Setae, **c.** Conidiogenous cells with attached conidial chains, **d.** Conidia.

in 2-3-ramosa, infra uniseriata vel supra bi- ad triseriata, 75-85 µm longa, 2.5-4 µm lat.; cellulae apicale ad basale conicale vel obclavatae, 7-9 x 2.5-3.5 µm; cellulae

intermediatae cylindricale, terminale truncatae, 8-10 x 2.5-4 µm; in massis hyalina vel atrobrunneae.

HOLOTYPUS, In foliis putrescentibus *Holigarna arnotiana* (Wt. & Arn.) Hook.f., Cotigao Wildlife Sanctuary, Goa, India, 11 March 1999, Keshava Prasad, Herb. No. IMI 387091.

Terrestrial litter hyphomycete. *Colonies* effuse, olivaceous brown to dark brown. *Mycelium* partly superficial, partly immersed, composed of septate, branched, colourless to pale brown hyphae 2.5-3.5 µm wide. *Conidiomata* sporodochial, solitary, pulvinate, slightly elevated, with 8-16 setae arising from the margin of the base. *Setae* subulate, acute at the apex, septate, thick-walled, dark brown, smooth, protruding beyond the level of conidiophores and conidial mass, 300-400 x 7-10µm. *Conidiophores* mononematous, erect, short, arising in groups, septate, 1-2 times branched, thin-walled, colourless, smooth, 15-30µm long, 2-4.5 µm wide. *Conidiogenous cells* polyblastic, discrete, terminal, hyaline, smooth, with denticulate scars at the rounded apex. *Conidia* hyaline, smooth, aseptate, in 2-3-branched chains of 75-85 µm long, 2.5-4 µm wide, connected by narrow isthmi, uniseriate below, bi- to triseriate above, with branches arising from the third and forth cells of the main axis, of two types: apical and basal cells conical to obclavate, 7-9 x 2.5-3.5 µm; intermediate cells cylindrical with truncate ends, 8-10 x 2.5-4 µm; in mass initially whitish, later becoming pale brown.

Dematiaceous genera of Hyphomycetes producing unicellular conidia connected by narrow isthmi can be grouped into two catagories based on the branching of conidial chains. The genus *Wiesneriomyces* Koorders (1907), typified by *W. laurinus* (Tassi) P.M. Kirk (1984), producing unicellular conidia in unbranched chains in setose sporodochia has been known on terrestrial litter from many parts of the world (Subramanian, 1956; Manotis & Strain, 1968; Ellis, 1971, 1976; Matsushima, 1971, 1975; Kirk, 1983; Shaw & Sutton, 1985; Kuthubutheen & Nawawi, 1988). The genus *Isthmolongispora* Matsushima (1971, 1975), typified by *I. intermedia* Matsushima, is mononematous with conidia developing in unbranched chains. The genus *Speiropsis* Tubaki (1958), with *S. pedatospora* Tubaki as type species, is mononematous but has conidia in branched chains. The conidia of these litter inhabiting fungi are often recovered from freshwater stream habitat.

The genus *Phalangispora* Nawawi & Webster (1982), typified by *P. constricta* Nawawi & Webster, produces pale brown conidia in branched chains from setose sporodochia. The fungus has been reported from freshwater streams. The second species in the genus, *P. nawawi* Kuthubutheen (1987), differs from the type by its smaller-sized conidia and conidial chains and presence of fewer cells in the main axis of the conidial chain. In *P. constricta*, the conidia are 11-20 x 2.5-4 µm whereas in *P. nawawi* these are 10-12 x 2 µm. The conidial chains are 120-140 x 3-4 µm in *P. constricta* and 65-90 x 2 µm in *P. nawawi*. The branches in *P. constricta* and *P. nawawi* arise generally from the second and third cells of the main axis of conidial chain.

Unlike *P. constricta* and *P. nawawi*, in *P. bharathensis*, the branches arise from the third and forth cells of the main axis of the conidial chain. Although the overall dimension of the conidial chains is similar to that of *P. nawawi*, in *P. bharathensis* the intermediate conidial cells are 8-10 x 2.5-4 µm. Further, the number of cells in the main axis of the conidial chain in *P. bharathensis* is 8-11 (mostly 9) whereas in *P. nawawi*, it is always 6-

8. Individual conidia are wider in *P. bharathensis* (2.5-4 μm) than those of *P. nawawi* (up to 2 μm).

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# NATS TRUFFLE AND TRUFFLE-LIKE FUNGI 9: GASTROBOLETUS MOLINAI SP. NOV. (BOLETACEAE, BASIDIOMYCOTA), WITH A REVISED KEY TO THE SPECIES OF GASTROBOLETUS

Eduardo Nouhra

Instituto Multidisciplinario de Biología Vegetal, Universidad Nacional de Córdoba,
Casilla de Correo, 495 5000 Córdoba, Argentina

Michael A. Castellano

U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station,
3200 SW Jefferson Way, Corvallis Oregon 97331; E-mail: mcastellano@fs.fed.us

James M. Trappe

Department of Forest Science, Oregon State University, Corvallis, Oregon 97331-5752;
E-mail: trappej@ucs.orst.edu

## ABSTRACT

A new sequestrate species in the Boletaceae, *Gastroboletus molinai,* is described from Butte County, California. A revised key to all *Gastroboletus* species is presented.

**Keywords:** Basidiomycete, sequestrate, bolete

## INTRODUCTION

Thiers (1989) divided *Gastroboletus sensu lato* into several genera of differing phylogenies. *Gastroboletus sensu stricto* is characterized by *Boletus*-like but sequestrate and usually hypogeous basidiomata with reduced or absent stipe and tubes that are distorted and often plugged with cross walls. Spores cannot discharge from these tubes, even if they are released from the basidia, so spore dispersal depends primarily on animal mycophagy. A number of new species in the genus *Gastroboletus* have been proposed (Cázares & Trappe 1991; Nouhra & Castellano 1995; Trappe & Castellano 2000; Zang 1995) since Thiers' (1989) realignment. Over the last 30 years, numerous collecting expeditions in the western United States have produced many undescribed sequestrate taxa. One such was found adjacent to a forest nursery in northern California. We describe it as a new *Gastroboletus* species and present a revised key to all known *Gastroboletus* species.

## METHODS

Methods of collection and macroscopic and microscopic study were generally those of Castellano et al. (1989). Colors of fresh specimens are in general terms. Hand-cut sections of both fresh and dried material were mounted in 5% KOH or Melzer's reagent for standard light microscopy. Spore dimensions are based on the measurement of 30 randomly selected spores mounted in KOH; spore lengths include sterigmal attachment. Measurements of sterile tissues (e.g., peridium) and spores are from mature sporocarps. The holotype is deposited in the Mycological Herbarium of Oregon State University (OSC).

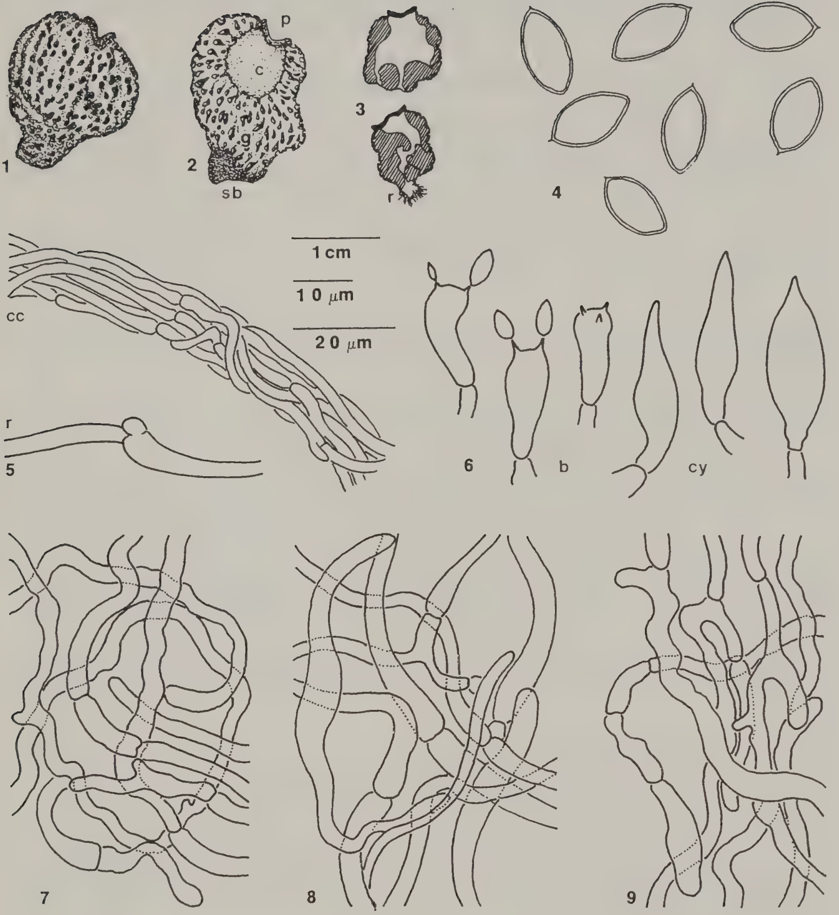
## TAXONOMY

***Gastroboletus molinai*** Nouhra, Castellano & Trappe sp. nov. Figs. 1-9

*Basidiomata hypogaea, usque ad 13 mm alta et 15 mm lata, subglobosa vel turbinate. Peridium circulare, ad apicem basidiomatis, coactum, brunneolum, rubro suffusum. Tubi convoluti e irregulares, juventute flavissimi, tarde rubescentes, maturitate brunnei vel obscure porphyrei. Columella discontinua vel percurrens, 1-6 mm lata, dilute glandacea vel brunneola. Rhizomorphae numerosae, tenues, basi columellae concolorae. Peridium 150-300 μm latum, hyphis hyalinis, 2.5-5 μm diametris. Trama hyphis hyalinis, divergentibus, 2-5 (-10) μm diametris. Basidia clavata vel subcylindricalia, hyaline, 31-52 x 12-20 μm. Cystidia fusiformia, hyalina, 57-85 x 12.5-20 μm. Fibulae destitutae. Sporae laeves, laterale symmetricales, ellipsoideae, 11-17 (-20) x 5-8 μm, parietes 0.5-1 μm crassi, in KOH luteo-olivaceae.*

**Basidiomata** hypogeous, up to 13 mm tall and 15 mm in diam, subglobose to turbinate, the reduced stipe projecting up to 2 mm beyond the base. **Peridium** covering a circular patch at the top of the basidioma, felty, pale brown with a slight rose blush. **Tubes** with mouths exposed on sides and bottom of basidioma, much convoluted and irregular, bright yellow section, when young and slowly staining red where bruised, in age brown or dark red-brown, divided into chambers that are yellow at first, then olive, and finally dark olive. **Columella** discontinuous from base or percurrent by 1-2 narrow columns 1-6 mm broad, pale yellow brown to pale brown. **Rhizomorphs** numerous, thin, concolorous with and emergent from the columella base. **Odor** faint, pleasant, fruity. **Taste** not determined.

**Peridium** 150-300 μm thick, of thin-walled, hyaline, tightly interwoven hyphae 2.5-5 μm in diam. **Trama** of thin-walled, hyaline, divergent hyphae 2-5 (-10) μm in diam. **Basidia** clavate to subcylindrical, thin-walled, hyaline, 31.0-52.5 x 12-20 μm (mean 38.0 x 13 μm), 2 or 4 spored; sterigmata 2.5-4.0 μm tall. **Cystidia** fusiform, thin-walled, hyaline, 57-85 x 12.5-20 μm (mean 72.0 x 16.0 μm). **Sterile base** composed of



Figs. 1-9. *Gastroboletus molinai*. 1. Basidioma surface view. Scale bar = 1 cm. 2. Basidioma cross-section; p = peridium, g = gleba, sb = sterile base, c = columella. Scale bar = 1 cm. 3. Basidioma cross-section showing branched columella; r = rhizomorphs attached to the sterile base. Scale bar = 1 cm. 4. Spores. Scale bar = 10 µm. 5. Rhizomorph surface view; cc = clamp connection. Scale bar = 20 µm. 6. Basidia; cy = cystidia. Scale bar = 20 µm. 7. Columella hyphae. Scale bar = 20 µm. 8. Peridium hyphae. Scale bar = 10 µm. 9. Sterile base hyphae. Scale bar = 10 µm.

irregularly branched, thin-walled, hyaline, interwoven hyphae, 2.5-5.0 μm in diam, some areas with parallel hyphae. **Columella** of thin-walled, hyaline, irregularly branched, interwoven hyphae, 5-10 μm in diam. **Rhizomorphs** of thin-walled, subparallel to interwoven hyphae, 2.5-17.5 μm.

**Clamp connections** present in rhizomorphs but absent from the basidiomata.

**Spores** smooth, bilaterally symmetric, ellipsoid, 11-17 (-20) x 5-8 μm (mean 14.5 x 6.7 μm); the walls 0.5-1.0 μm thick, the apiculus conspicuous, in KOH yellow-olive singly and in mass, nonreactive in Melzer's reagent.

**Etymology**: "*molinai*" named in honor of Randy Molina, collector of the type and accomplished mycologist.

**Distribution, habitat and season**: Known only from the type collection in northern California under *Quercus chrysolepis*, June.

**Collection examined**: HOLOTYPE—**California**, Butte Co., eastern edge of Magalia adjacent to forest nursery, 16 June 1980, R. Molina, Trappe #5794. (OSC).

**Discussion**: *Gastroboletus molinai* resembles *G. ruber* (Zeller) Cázares & Trappe, but its spores and cystidia are larger than those of *G. ruber*. *Gastroboletus molinai,* like *G. amyloideus* Thiers, *G. brunneus* Thiers, and *G. vividus* Trappe & Castellano, does not stain blue when cut or bruised. The amyloid spores of *G. amyloideus* readily distinguish it from *G. molinai*. Both *G. brunneus* and *G. vividus* lack cystidia whereas *G. molinai* has them.

*Gastroboletus molinai* belongs in section *Gastrosubtomentosi* based on the red overtones of the basidiomata, dry peridial surface and structure of the peridium (Thiers 1989).

## **Key to Gastroboletus species** (after Thiers 1989)

1. Gleba covered with white hyphae when young; tube mouths white; stipe usually reticulate near apex.......... ***G. subalpinus*** Trappe & Thiers (Thiers & Trappe 1969)
1. Gleba and tube mouths not white, stipe not reticulate.......................................... **2**

    2. Coarse, fibrillose scales on cap surface, Africa................................................ ................................................................ ***G. fascifer*** Singer &Smith (1964)
    2. Cap without coarse fibrillose scales, not in Africa........................................... **3**

3. Many spores truncate.......................................................................................... **4**
3. Spores not truncate or only a few appearing so.................................................... **5**

4. Spores partially amyloid, particularly near apex and base; tubes vivid yellow .................................................. ***G. citrinibrunneus*** Thiers (1979)
4. Spores inamyloid, tubes dull dark yellow to golden yellow.............................. .............................. ***G. xerocomoides*** Trappe & Thiers (Thiers & Trappe 1969)

5. Context and/or tubes not bluing when cut or bruised.............................................**6**
5. Context and/or tubes bluing when cut or bruised.................................................**10**

6. Spores amyloid in mass.............***G. amyloideus*** Thiers (Thiers & Trappe 1969)
6. Spores nonreactive to Melzer's reagent.........................................................**7**

7. Cystidia present ..........................................................................................**8**
7. Cystidia absent.............................................................................................**9**

8. Cystidia fusiform, 57-85 x 12.5-20 µm; North America................... ***G. molinai***
8. Cystidia ventricose, 30-44 x 8-11 µm; China..........***G. boedijni*** Lohwag (1926)

9. Basidioma with vivid yellows and reds, spores 13-18 (-22) x 6-7 (-8) µm ........................................................... ***G. vividus*** Trappe & Castellano (2000)
9. Basidioma with some red tones but mostly dark olive-brown, spores 11.5-14.5 x 5.5-7.5 µm........................................................... ***G. brunneus*** Thiers (1989)

10. Trama amyloid, spores highly variable in length, 7-17.5 x 6-7 µm.................... ......................................................... ***G. dinoffii*** Nouhra & Castellano (1995)
10. Trama inamyloid, spores more uniform in length..........................................**11**

11. Spores < 6.5 µm wide.....................................................................................**12**
11. Spores 6.5-9.5 µm wide..................................................................................**13**

12. Stipe-columella reduced, peridium evanescent; North America........................ ........................................................***G. ruber*** (Zeller) Cázares & Trappe (1991)
12. Stipe-columella distinct, peridium reduced but present; Chile ........................................................................... ***G. valdivianus*** Horak (1977)

13. Spores less than 18 µm long; North America...................................................**14**
13. Spores 20-26 µm long; New Caledonia...................................***G. doii*** Zang (1995)

14. Spores (9.5-) 13.5-18 (-20) x (5.5-) 6.5-9.5 µm ............................................... ............................ ***G. turbinatus*** var. ***turbinatus*** (Snell) Smith & Singer (1959)
14. Spores 11-14 x 7-9 µm .................................................................................... .......................... ***G. turbinatus*** var. ***flammeus*** Smith in Smith & Singer (1959)

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# NEW COMBINATIONS IN CHLOROPHYLLUM

ELSE C. VELLINGA

Department of Plant and Microbial Biology, University of California at Berkeley,
111 Koshland Hall # 3102, Berkeley CA 94720-3102, U.S.A. / Nationaal Herbarium, P.O. Box
9514, 2300 RA Leiden, the Netherlands
Email vellinga@uclink4.berkeley.edu

**Abstract:** Taxonomic studies in *Lepiota* s. l. and *Endoptychum*, based both on morphological and molecular data resulted in new combinations.

**Key words:** Agaricaceae, nomenclature, novelties

## INTRODUCTION

The genus *Macrolepiota* Singer is not monophyletic, and it was split up into two genera on morphological and molecular grounds (Vellinga et al., submitted). The genus *Macrolepiota* in its restricted sense is characterized by a trichodermal pileus covering, the presence of stipe covering, visible as coloured bands on the stipe, and spores with a rounded apex with a hyalinous covering over the germ pore. The sections *Macrolepiota* and *Macrosporae* (Singer) Bon, with subsections *Excoriatae* M. Bon and *Microsquamatae* (Pázmány) Bellù & Lanzoni of the infrageneric classification advocated by Bon (1993), belong to this genus.

The second genus comprises *Chlorophyllum* Massee, *Endoptychum agaricoides* Czern., *Leucoagaricus hortensis* Murrill, and *Macrolepiota* section *Laevistipedes* (Pázmány) Bon (*M. rachodes* and allies). This genus is characterized by a hymenodermal pileus covering, a smooth stipe, and spores with or without a germ pore, without a hyalinous covering. The spores may be white or green or brownish in deposit, and the habit varies from agaricoid to secotioid. A proposal to conserve the name *Chlorophyllum* against *Endoptychum* has been put forward (Vellinga & De Kok, submitted). New combinations in *Chlorophyllum* have to be made, and are proposed here.

Molecular studies have repeatedly shown that morphological species definitions of basidiomycetes have to be reconsidered (e.g. Johannesson et al. (1999) on *Sarcodon imbricatus* (L.: Fr.) P. Karst. and *S. squamosus* (Schaeff.) Quél.; Vellinga (2001) on *Lepiota cristata* (Bolt.: Fr.) P. Kummer and *L. castaneidisca* Murrill). For this reason is seems advisable to transfer also those species, which are still considered to be synonymous.

## NEW COMBINATIONS

**Chlorophyllum abruptibulbum** (R. Heim) Vellinga, comb. nov.
Basionym: *Leucocoprinus abruptibulbus* R, Heim in Rev. Mycol. 33: 213. 1968.

**Chlorophyllum agaricoides** (Czern.) Vellinga, comb. nov.
Basionym: *Endoptychum agaricoides* Czern. in Bull. Soc. imp. Nat. Moscou 18 (2): 148. 1845

**Chlorophyllum alborubescens** (Hongo) Vellinga, comb. nov.
Basionym: *Lepiota alborubescens* Hongo in Mem. Fac. lib. Arts Educ. Shiga Univ., nat. Sci. 12: 40. 1962.

**Chlorophyllum brunneum** (Farl. & Burt) Vellinga, comb. nov.
Basionym: *Lepiota brunnea* Farl. & Burt, Icones farlowianae: 8, pl. 6. 1929.

**Chlorophyllum globosum** (Mossebo) Vellinga, comb. nov.
Basionym: *Macrolepiota globosa* Mossebo in Mycotaxon 76: 268. 2000.

**Chlorophyllum hortense** (Murrill) Vellinga, comb. nov.
Basionym: *Lepiota hortensis* Murrill in N. Amer. Fl. 10 (1): 59. 1914.

**Chlorophyllum humei** (Murrill) Vellinga, comb. nov.
Basionym: *Lepiota humei* Murrill in Lloydia 6: 220. 1943.

**Chlorophyllum mammillatum** (Murrill) Vellinga, comb. nov.
Basionym: *Lepiota mammillata* Murrill in Lloydia 6: 220. 1943.

**Chlorophyllum neomastoideum** (Hongo) Vellinga, comb. nov.
Basionym: *Lepiota neomastoidea* Hongo in Mem. Fac. lib. Arts Educ. Shiga Univ., nat. Sci. 20: 51. 1970.

**Chlorophyllum olivieri** (Barla) Vellinga, comb. nov.
Basionym: *Lepiota olivieri* Barla in Bull. Soc. mycol. Fr. 2: 113. 1886.

**Chlorophyllum rachodes** (Vittad.) Vellinga, comb. nov.
Basionym: *Agaricus rachodes* Vittad., Descr. Funghi mang. Italia: 158. 1835.

**Chlorophyllum subfulvidiscum** (Murrill) Vellinga, comb. nov.
Basionym:*Lepiota subfulvidisca* Murrill in Lloydia 6: 221. 1943.

**Chlorophyllum subrhacodes** (Murrill) Vellinga, comb. nov.
Basionym: *Lepiota subrhacodes* Murrill in Lloydia 6: 223. 1943.

## DOUBTFUL NAME

*Agaricus fimetarius* Cooke & Massee in Cooke in Grevillea 18: 1. 1889, non *Agaricus fimetarius* L., 1753, nec *Agaricus fimetarius* Bolton, 1788; *Lepiota fimetaria* Cooke & Massee → Sacc., Syll. Fung. 9: 7. 1891; *Leucoagaricus fimetarius* (Sacc.) Aberdeen, Lepiotoid Genera (Agaricales) in South-Eastern Queensland: 8. 1992.

*Leucoagaricus fimetarius* sensu Aberdeen (1992) is the same species as *Chlorophyllum hortense*, because of the double annulus, the reddening of the stipe, and spores without a distinct germ pore; Aberdeen did not give the number of sterigmata per basidium. Saccardo (1891) in the original description (based on Cooke & Massee in Cooke, 1889), described a small fungus, with a pileus 14-18 mm in diameter, a stipe of 3-5 cm long, a fugacious annulus, and a squamose stipe. The latter is emphasized in the comments, where is noted that *Lepiota fimetaria* is close to *L. subclypeolaria* (Berk. & Br.) Sacc., but with a distinctly squamose stipe. This description is quite different from Aberdeen's interpretation of the species. *Chlorophyllum hortense* is one of the few species in the Agaricaceae with 2-spored basidia. Howevever, Aberdeen (1962), who studied Cooke & Massee's collection of *Agaricus fimetarius*, did not comment on the number of spores per basidium, nor did he note the absence or presence of clamp-connections, another important character in this group (*Chl. hortense* is provided with clamp-connections).

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# TWO INTERESTING CENTRAL AFRICAN COLLECTIONS OF PHYSALACRIA (BASIDIOMYCETES, AGARICALES): P. CAMERUNENSIS SP. NOV. AND THE FIRST AFRICAN RECORD OF P. TROPICA

VLADIMÍR ANTONÍN
Moravian Museum, Dept. of Botany, Zelný trh 6, CZ-659 37 Brno,
Czech Republic; e-mail: vantonin@mzm.cz
&
DOMINIQUE CLAUDE MOSSEBO
University of Yaoundé 1, Mycological Laboratory, B.P. 1456, Yaoundé,
Cameroon; e-mail: mossebo@uycdc.uninet.cm

**Abstract** Notes are provided on two interesting collections of *Physalacria* (Basidiomycetes, Agaricales, Tricholomataceae). *Physalacria camerunensis*, collected in the Dja Biosphere Reserve (Cameroon, Central Africa), is described as a new species and *P. tropica* is recorded in Africa for the first time.

**Key words:** new taxa, Tricholomataceae, tropical Cameroon

The genus *Physalacria* Peck represents a group of about 30 species with an interesting macromorphology, having globose to conical, hollow heads with a short stipe. According to some authors (e.g. Corner 1950), it belongs in the Aphyllophorales, others (e.g. Hawksworth et al. 1995) have placed it in the Cantharellales, still others (e.g. Donk 1964; Horak & Desjardin 1994; Inderbitzin & Desjardin 1999; Rammeloo 1978; Singer 1986) in the tribe Marasmieae of the Tricholomataceae (Agaricales). We agree with the last authors that species of the genus *Physalacria* represent reduced agarics.

During our mycological stay in the Dja Biosphere Reserve (Cameroon, Central Africa), two interesting *Physalacria* species were found. After searching the literature, we identified one collection as *P. tropica* Corner. The second collection differed from all known species, so we have therefore decided to describe it as new. The forest types present in the Dja Biosphere Reserve have already been briefly characterized by Núñez & Daniëls (1999).

Microscopic features are described from examined material mounted in Melzer's reagent, KOH and Congo Red. Authors of fungal names are cited according to Kirk & Ansell (1992).

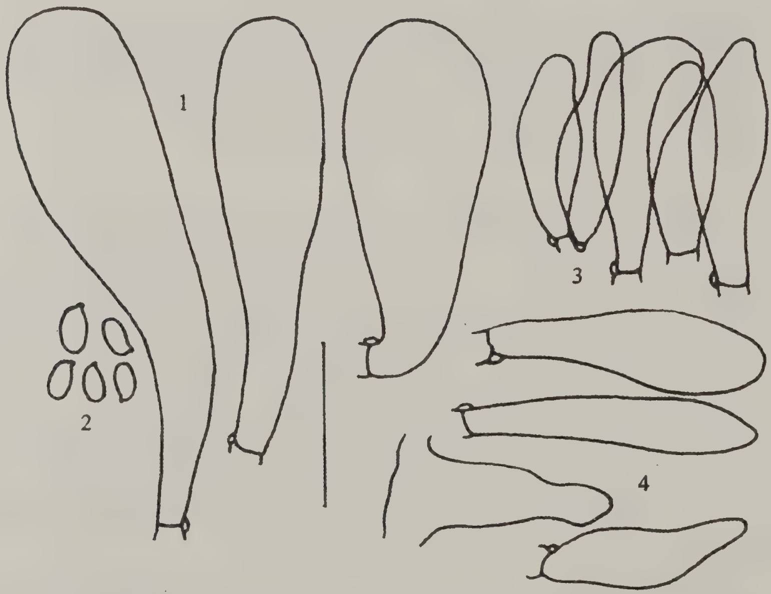
***Physalacria camerunensis*** **Antonín & Mossebo sp. nov.** (Figs. 1-4)

Carpophora 3-9 mm alta. Capitulum 1-4 mm latum, ellipsoideum vel paraboloideum, plicatum, cremeo-album. Stipite 2-5 x -0.5 mm, cylindraceo, cum disco basale. Basidiosporis 4.2-5.0(-6.0) x 2.0-3.0 µm, ellipsoideis, indextrinoideis. Basidiis tetrasporidis. Cystidiis 35-75 x (8.0-)10-17 µm, (latae) clavatis, oleiferis, hyalinis. Caulocystidiis 20-40 x 7.0-11(-17) µm, clavatis, (sub)cylindraceis, fusiformibus, lageniformibus. Hyphis inamyloideis, fibulatis.

Holotypus: Cameroon, regio protecta Dja, 10 April 2001, leg. C. Decock (V. Antonín 01.78, holotypus in herbario BRNM 666146 asservatur).

Carpophores 3-9 mm high, growing in dense groups with capitula ± stuck together. Capitulum up to 4 mm high, 1-4 mm broad, ellipsoid, paraboloid, hollow, obtuse at apex, longitudinally grooved (plicate), smooth, milky white outside and inside, plicate near stipe, apparently without openings. Stipe 2-5 x up to 0.5 mm, central or eccentric, cylindrical, slightly tomentose, adnexed with a small tomentose disc, white.

Basidiospores 4.2-5.0(-6.0) x 2.0-3.0 µm, ellipsoid, slightly thick-walled, smooth, hyaline, non-dextrinoid. Basidia 30 x 5.0 µm, 4-spored, narrowly clavate. Basidioles 15-25 x 2.0-5.0 µm, narrowly clavate, fusoid, cylindrical, often rostrate. Trama hyphae cylindrical, ± thin-walled, hyaline, non-dextrinoid, 2.0-5.0 µm wide. Hymenial cystidia (gloeocystidia) 35-75 x (8.0-)10-17 µm, (broadly) clavate, oleiferous, thin-walled, hyaline in KOH, not or slightly protruding from the hymenium. Lower part of capitulum near stipe sterile, covered by clavate, fusoid, or subcylindrical, often rostrate, hyaline cells, 15-35 x 7.0-15 µm, mixed with scattered oleiferous cystidia simi-



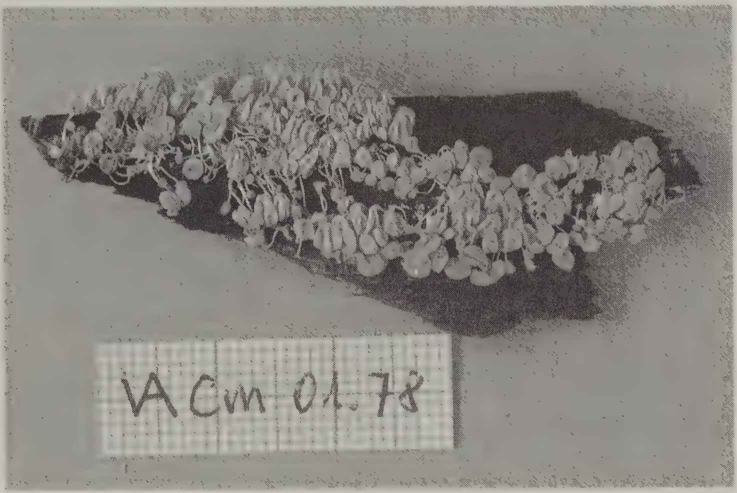
Figs. 1-4. *Physalacria camerunensis* (holotype): 1. hymenial cystidia, 2. basidiospores, 3. cells of the sterile lower part of capitulum, 4. caulocystidia. Scale bar = 20 µm.

lar to hymenial ones. Stipitipellis a cutis, of cylindrical, parallel, thin-walled, hyaline, smooth or sparsely diverticulatehyphae up to 8.0 µm wide. Caulocystidia numerous, 20-40 x 7.0-11(-17) µm, clavate, (sub)cylindrical, fusoid, lageniform, sometimes (sub) rostrate, slightly thick-walled, hyaline in KOH. Clamp-connections present in all tissues.

Ecology: On dead branch.

Holotype: Cameroon, Dja Biosphere Reserve, ca. 34 km E of Somalomo, N 03°20′44", E 13°02′15", alt. ca. 650 m, 10 April 2001, leg. C. Decock (V. Antonín 01.78, BRNM 666146).

*Physalacria camerunensis* is characterized by having small carpophores with ± ellipsoid, distinctly plicate capitula not coalescing (only stuck together), the stipe inserted with a tomentose basal disc, 4-spored basidia, and long and broadly clavate oleiferous cystidia. Microscopically, it is similar to *P. tropica* Corner except for broader gloeocystidia; however, its macromorphology is quite different. Other species can be distinguished by their microscopic and/or macroscopic characters (Berthier 1985; He Xian, Xue Fengzhi & Li Xiliang 1996; Inderbitzin & Desjardin 1999; Rammeloo 1978).



*Physalacria camerunensis*: Cameroon, Dja Biosphere Reserve, type specimen (dry carpophores). Scale 30 x 10 mm.

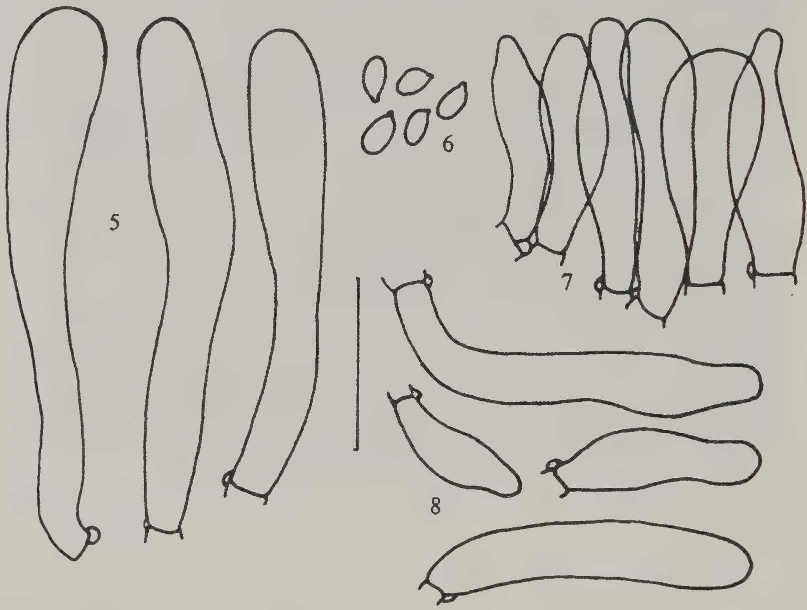
## ***Physalacria tropica* Corner** (Figs. 5-8)

Carpophores up to 25 mm high, growing closely together and coalescing, having joint irregular capitula with multiple stipes. Capitulum ± (sub)globose, irregular, lobate, thin-walled, hollow, smooth, milky white outside and inside, with scattered openings near stipe. Stipe 5-15 x 1-1.5 mm, cylindrical to tapering towards base, insititious, distinctly pubescent, slightly longitudinally fibrillose, white at apex, brownish-greyish to blackish at base.

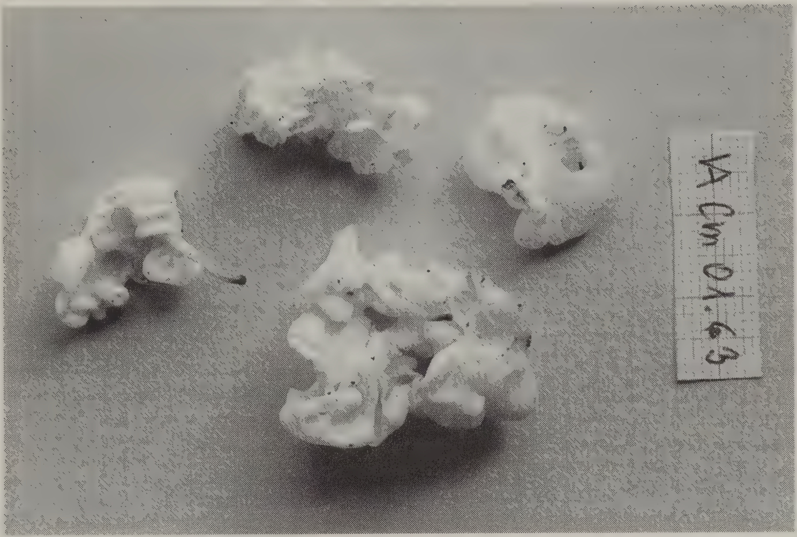
Basidiospores 4.2-5.2(-6.0) x 2.2-3.0 µm, ellipsoid, slightly thick-walled, non-dextrinoid, hyaline, with one guttula. Basidia 21-26 x 3.5 µm, 4-spored, narrowly clavate. Basidioles 15-30 x 2.0-4.0 µm, (sub)fusoid to clavate, sometimes rostrate, thin-walled. Trama hyphae ± cylindrical, thin-walled, branched, non-dextrinoid, up to 6.0 µm wide. Hymenial cystidia (gloeocystidia) 30-75 x 7.0-11(-17) µm, clavate, long, with oleiferous contents, thin-walled, slightly thick-walled at apex or throughout, hyaline in KOH, not (or only slightly) protruding from the hymenium. Lower part of capitulum near stipe sterile, covered by clavate, fusoid, lageniform, awl-form, thin-walled, ± hyaline cystidia, 15-45 x 7.0-13 µm, mixed with scattered oleiferous cystidia similar to hymenial ones. Stipitipellis a cutis, of parallel, cylindrical, thin-walled to slightly thick-walled hyphae up to 7.0 µm wide. Caulocystidia numerous, (16-)22-45 x 6.0-13 µm, clavate, fusoid, (sub)cylindrical, thin- to slightly thick-walled. Clamp-connections present in all tissues.

Ecology: On dead branch.

Locality: Cameroon, Dja Biosphere Reserve, ca. 14 km ESE of Somalomo, N 03°20´25", E 12°51´09", alt. ca. 690 m, 9 April 2001, leg. C. Decock and V. Antonín 01.63 (BRNM 666133).



Figs. 5-8. *Physalacria tropica* (Antonín 01.63): 5. hymenial cystidia, 6. basidiospores, 7. cells of the sterile lower part of capitulum, 8. caulocystidia. Scale bar = 20 µm.



*Physalacria tropica*: Cameroon, Dja Biosphere Reserve. Scale 30 x 10 mm.

*Physalacria tropica* is characterized by having large carpophores with irregular to lobate capitula, which always grow together, and rather narrowly clavate gloeocystidia. Berthier (1985) mentioned two types of cystidia, the larger ones 40-55 x 12-18 µm and the smaller ones 25-30 x 7-10 µm. In our collection, the length of cystidia was continuous from 30 to 75 µm and cystidia wider than 11 µm were very rare. We have therefore only given a single size range for all of them. In other macroscopic and microscopic features, the collection agreed very well with the description by Berthier (1985).

Three *Physalacria* species have been collected in Africa to date: *P. decaryi* Pat. (Madagascar), *P. macrocystidiata* Rammeloo (Rwanda), and *P. togoensis* (Henn.) Corner (Togo). *Physalacria camerunensis* represents a fourth African species and our collection of *P. tropica* (the first in Africa) a fifth.

*Physalacria decaryi* differs especially in having a ± conical capitulum, slightly broader spores and cystidia with conical apex distinctly protruding above the hymenium (Berthier 1985), *P. macrocystidiata* by the different appearance of the carpophores and capitate cystidia without oleiferous content (Rammeloo 1978), and *P. togoensis* by its very small carpophores with globose capitulum, subglobose spores and distinctly smaller cystidia (Berthier 1985).

## Acknowledgments

The authors wish to thank to Cony Decock (Université Catholique de Louvain Place, Louvain-la-Neuve, Belgium) for sending us the collection of *P. camerunensis*, and to the ECOFAC NGO for kindly accommodating us in the Somalomo Biological Station. The study of this group is part of a larger taxonomic project by the first author, supported by the Grant Agency of the Czech Republic No. 206/01/0093.

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# STUDIES IN THE GENUS PSATHYRELLA IN SPAIN. IV. PSATHYRELLA SUBMICROSPORA SP. NOV. AND P. MICROSPOROIDES NOM. NOV.

**M. HEYKOOP & G. MORENO**
Dept. of Plant Biology, Universidad de Alcalá
28871 Alcalá de Henares, Spain

**Abstract:** New species *Psathyrella submicrospora* in the section Spintrigerae and new name *P. microsporoides* for *P. badiophylla* var. *microspora* are proposed.

**Key words:** morphology, taxonomy, P. typhae, P. magnispora

After compiling all the records of the genus *Psathyrella* in the Iberian Peninsula (HEYKOOP, 2001) within the framework of the research project "Flora Micológica Ibérica IV", we can conclude that this genus, as we suspected, has been very poorly studied and the available data are clearly insufficient. In Spain a total of 69 taxa has been recorded (62 species, 3 varieties and 4 formae) (HEYKOOP, l.c.). However, for several reasons, which we will mention below, the real number of species undoubtedly must be much higher. In the first place, whereas Spain shows a ratio of 69 taxa of *Psathyrella* in relation to a vascular flora of 5048 species (exclusive the Canary Islands), with 941 endemisms (GROOMBRIDGE, 1992), other countries show a higher number of species in this genus. For instance, The Netherlands shows a ratio of 104 taxa of *Psathyrella* (96 species, 4 varieties and 4 formae; ARNOLDS & al., 1995) for 1221 vascular plants and 0 endemisms (GROOMBRIDGE, l.c.), an apparently much higher diversity, the more so because Holland presents a much lesser ecological diversity. Secondly, and according to the large amount of material of this genus collected by us which remains unpublished, the number of undescribed species must probably be very high. The lack of data in the knowledge of *Psathyrella* is due, as already mentioned before (HEYKOOP & ESTEVE-RAVENTÓS, 1994; HEYKOOP & MORENO, 1998, 2001) to the fact that mycologists pay very little attention to this genus in the field.

Continuing with our series of papers on the genus *Psathyrella* (HEYKOOP & ESTEVE-RAVENTÓS, 1994; HEYKOOP & MORENO, 1998, 2001; HEYKOOP, 2001), in this new contribution a new species, *Psathyrella submicrospora*, fruiting on basic calcareous soils in open areas of *Juniperus thurifera* and *Quercus rotundifolia* woods is described. In addition, after comparing *Psathyrella submicrospora* with the paratype of *P. badiophylla* var. *microspora* we conclude this latter taxon should better be considered a separate species. Since transfer of the epithet *microspora* to the rank of species would result in a later homonym we propose the new name *Psathyrella microsporoides* nomen novum.

***Psathyrella submicrospora*** Heykoop & G. Moreno sp.nov. **Figs. 1-15**

*Basidiomata solitaria vel gregaria. Pileus 5-11 mm latus, convexus vel plano-convexus, aliquot leviter campanulatus, hygrophanus, striatus, initio obscure brunneus vel spadiceo-brunneus vel vinosus, in sicco ochraceus vel ochraceo-cremeus, colore rosea destitutus. Velum albidum fugax. Lamellae brunneae vel leviter purpurascentes, adnatae, plus minusve crebrae, acie lamellarum alba. Stipes 17-30 x 1-2 mm, cylindraceus, albido-cremeus, obscuriore in parte inferiore, base leviter dilatata, ad apicem pruinatus. Odore saporeque nullis.*

*Sporae 7,6-7,7 x 4,8-5 μm (dimensiones mediae), amygdaliformes vel ellipsoideae, leves, in $NH_4OH$ 10% observatae aurantiaco-brunneae, non opocae, poro germinativo indistinctus (callus). Basidia 17-28 x 8-9 μm, clavata, 4-sporigera, fibulata. Pleurocystidia nulla. Cheilocystidia 30-46 x 12-15 μm, numerosa, utriformia vel cylindracea, hyalina, tenuitunicatis et incoloratis cellulis clavatis 8-23 x 11,5-13 μm immixtae. Trama lamellarum pigmento praedita.*
*Habitat: inter graminis in sylva Juniperus thuriferae et Quercus rotundifoliae.*
*Typus: Hispania, Tamajón (Guadalajara), 6-XI-1999, leg. M. Heykoop et M. Villarreal, Typus in herbario AH sub nº 27055 depositus.*

**Material examined:** Spain, Tamajón (Guadalajara), 6-XI-1999, leg. M. Heykoop & M. Villarreal, in open area in mixed wood of *Quercus rotundifolia* and *Juniperus thurifera* among mosses, AH 27055 (Holotypus) and AH 27056.
**Other material studied:** *P. badiophylla* var. *microspora* Kits van Wav. (**Figs. 16-28**), The Netherlands, Arnhem "open-air-museum", 22-IX-1984 (erroneously as 27-IX-84 in KITS VAN WAVEREN, 1985: 140), leg. J. Geesink, nº 1613, L0247228 (Paratypus).

Basidiomata isolated to gregarious, forming groups of 2-3 basidiocarps. Pileus 5-15 mm in diam., convex to applanate convex, some young specimen slightly campanulate (from above recalling a *Conocybe* or *Galerina*), hygrophanous, striate, at first very dark brown to vinaceous

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**Figs. 1-14** ***Psathyrella submicrospora*** AH 27055 (Holotypus). 1: Basidiocarps; 2-3: Basidia; 5-6: Spores; 7-14: Cheilocystidia.

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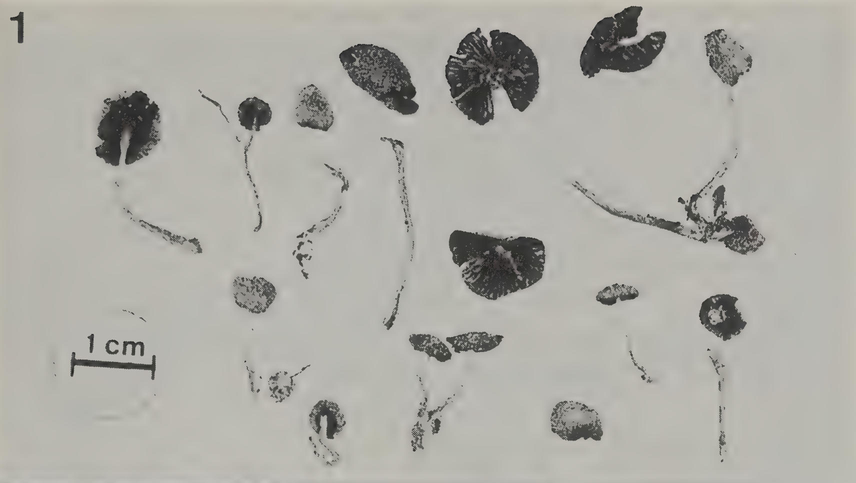

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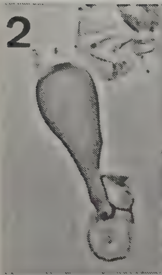

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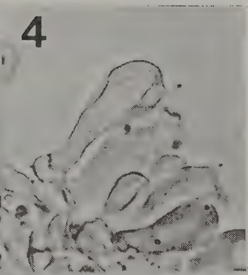

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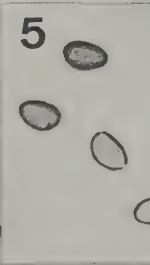

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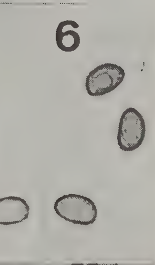

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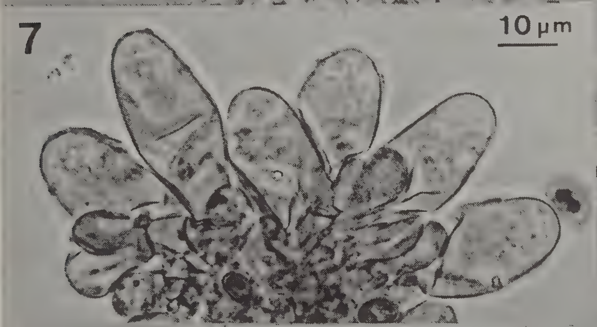

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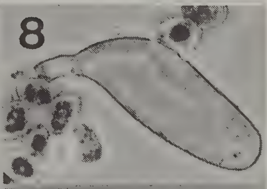

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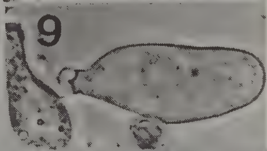

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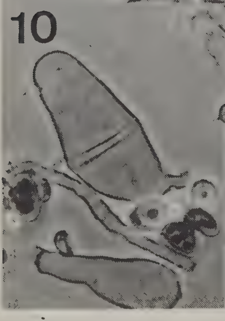

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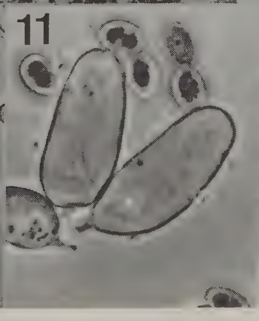

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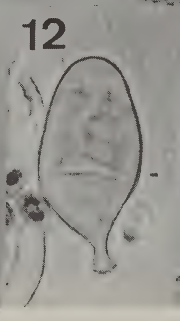

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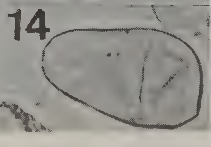

purplish or date brown, with a slightly darker umbo, drying out first at centre with ochraceous tinges, finally ochraceous-beige, without pink. The margin slightly lobulate (as in *P. orbitarum*). Veil whitish, fugacious but present in the younger basidiocarps. Gills brown with a purplish hue, adnate, more or less close, lamella-edge white. Stipe 17-30 x 1-2 mm, cylindrical, fragile, whitish-cream, darker in the lower part (2/3), the base sligthly widened, with pruinose apex. Smell and taste not distinctive. Spore print not recorded.

Spores amygdaliform to ellipsoid, some of them with a sharp-pointed apex, smooth, with a callus under the microscope, but without germ pore under S.E.M., dark orange-brown (in $NH_4OH$ 10%), not opaque,

- AH 27055: (6.5-)6.7-7.59-8.5 x 4.5-5.04-5.5 µm; Q=1.35-1.50-1.69(-1.73); (n=27)
- AH 27056: 7.0-7.65-8.6(-9.0) x 4.5-4.85-5.7(-6.0) µm; Q=1.40-1.58-1.76(-1.78); (n=24)

Basidia clavate, clamped, hyaline, tetrasporic, 17-28 x 8-9 µm. Pleurocystidia absent. Cheilocystidia 30-46 x 12-15 µm, abundant and densely packed, utriform to cylindrical, hyaline, intermixed with clavate cells, 8-23 x 11.5-13 µm, thin-walled and colourless. Hymenophoral trama consisting of hyphae with smooth membranal pigment, brown to orange-brown in mass, yellowish on the isolated hyphae.

**Discussion:** Because of the spore length (less than 10 µm) and the absence of pleurocystidia, this taxon belongs clearly to section *Spintrigerae* (Fr.) Konrad & Maubl. where, due to its small basidiocarps, spore size and strongly pigmented hymenophoral trama, it keys out (KITS VAN WAVEREN, 1985) as *Psathyrella badiophylla* var. *microspora* Kits van Wav. However, *P. submicrospora* differs from the latter in having a high number of amygdaliform spores which do not present a germ pore (Fig. 15).

CACCIALLI & DOVERI (1993) have published a complete description, as well as an illustration of *Psathyrella badiophylla* var. *microspora* which shows, without any doubt, that its spores always present a clear germ spore, wider than 1 µm. The macroscopic aspect of their photograph also differs from *P. submicrospora*, whose spores completely lack any germ pore.

Another species belonging to this section and lacking a germ pore is *Psathyrella typhae* (Kalchbr.) Pears. & Dennis. The latter, however, differs from *P. submicrospora* because of its very small size and its typical

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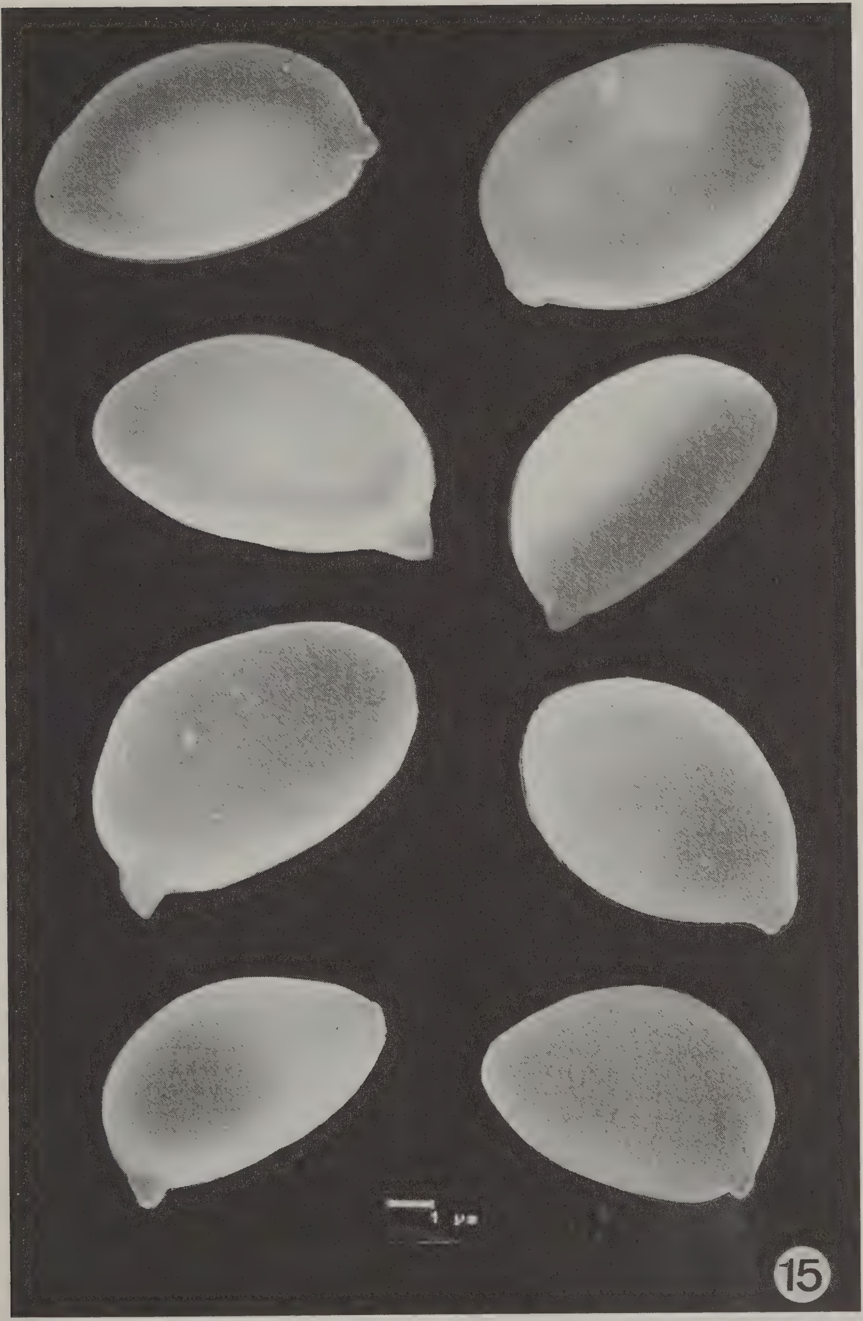
**Fig. 15** ***Psathyrella submicrospora*** AH 27055 (Holotypus). 15: spores under S.E.M.


1 μm
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habitat fruiting on live or dead (decaying) culms of different species of tall marsh plants such as *Typha*, *Epilobium*, *Scirpus*, *Phragmites*, etc.

*Psathyrella magnispora* Heykoop & G. Moreno, described recently by us (HEYKOOP & MORENO, 2001), is a species which shares with *P. submicrospora* the absence of a germ pore on the spores, its fructification in chalk grasslands and its medium size basidiocarps. It, nevertheless, differs by the presence of pleurocystidia, different spores and thick-walled yellowish cheilocystidia.

The differences between *P. submicrospora*, *P. badiophylla* var. *microspora*, *P. typhae* and *P. magnispora* are shown in Table I.

On the other hand, after revising the paratype of *Psathyrella badiophylla* var. *microspora* we could confirm the presence of spores with a germ pore, which show a very different morphology, being ellipsoid and never amygdaliform (figs. 17-18). Besides, the cheilocystidia are different in shape. Since the spore size of *P. badiophylla* var. *microspora* is significantly smaller than in *P. badiophylla*, a character of high taxonomic value within this genus, we conclude that this taxon deserves the rank of species. Transfer of the epithet *microspora* to the rank of species would result in a later homonym as there already exists a *Psathyrella microspora* (Imai) Hongo [In *J. Jap. Bot.* 27:194 (1952)]. Therefore we propose the following new name:

***Psathyrella microsporoides*** Heykoop & G. Moreno, **nomen novum**
= *Psathyrella badiophylla* var. *microspora* Kits van Wav., *Persoonia* Suppl., vol. 2: 139, 280 (1985); non *Psathyrella microspora* (Imai) Hongo, (1952); non *Psathyra microspora* Velen. (1947).

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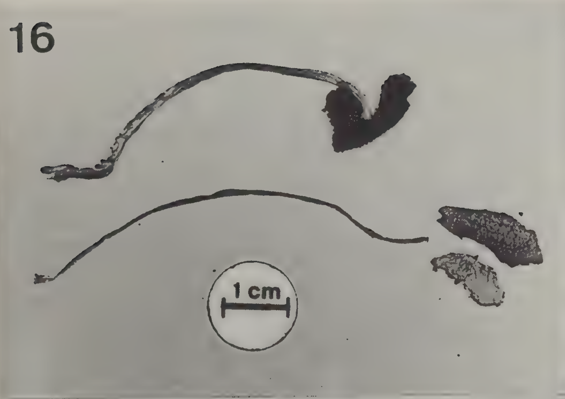
**Figs. 16-28 *Psathyrella badiophylla* var. *microspora*** (Paratype). 16: Basidocarps; 17-18: Spores; 19-24: Cheilocystidia; 25: Spore under S.E.M. with detail of the germ pore; 26-27: Spores under S.E.M.; 28: original label of the exsiccata.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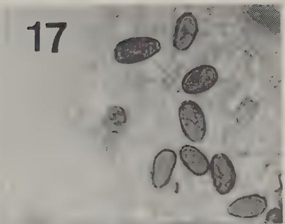
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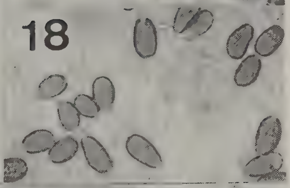
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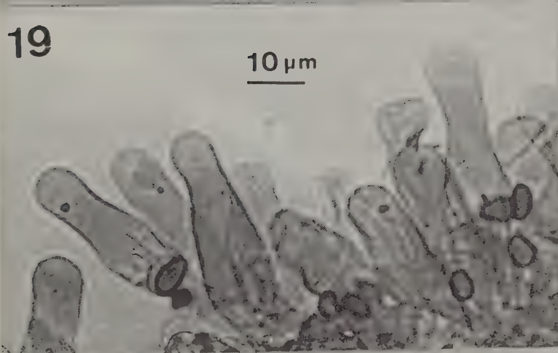
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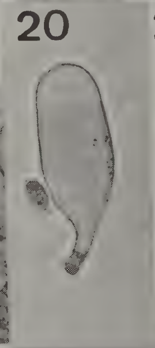
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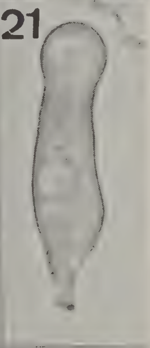
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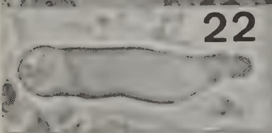
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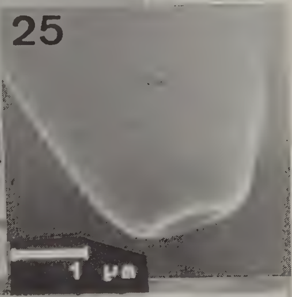
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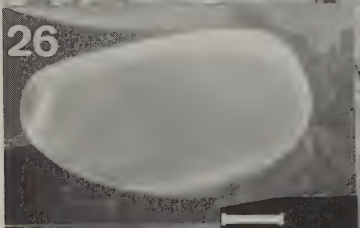
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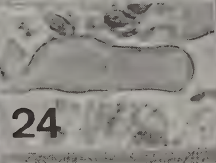
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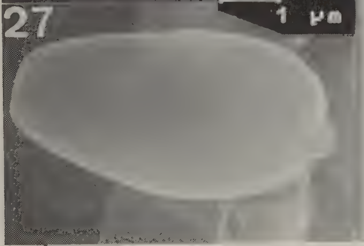
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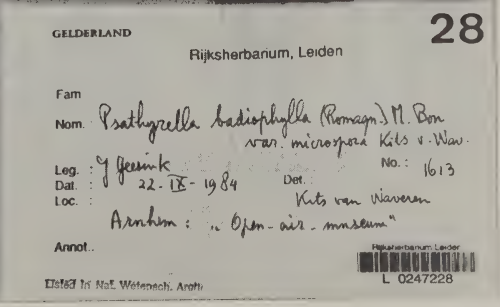
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GELDERLAND

Rijksherbarium, Leiden

Fam

Nom. Psathyrella badiophylla (Romagn.) M. Bon var. microspora Kits v. Wav.

Leg. : J Geesink No.: 1613

Dat. : 22-IX-1984 Det. : Kits van Waveren

Loc. : Arnhem: „Open-air-museum"

Annot..

Rijksherbarium Leiden

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[illegible] In Nat. Wetensch. Arnh

Table I: Differences between *Psathyrella submicrospora*, *P. microsporoides*, *P. typhae* and *P. magnispora*

| | Pleurocystidia | Germ pore | Spore shape | Cheilocystidia | Habitat |
|---|---|---|---|---|---|
| *Psathyrella submicrospora* | Absent | Absent | Amygdaliform to ellipsoid | Utriform to cylindrical, hyaline | In open calcareous areas in mixed wood of *Juniperus thurifera* and *Quercus rotundifolia* |
| *Psathyrella microsporoides* | Absent | Present | Ellipsoid | Utriform, hyaline | Terrestrial or against pieces of wood |
| *Psathyrella typhae* | Absent | Absent | Ellipsoid | Utriform to cylindrical or sublageniform, hyaline | On dead and live culms of tall marsh plants |
| *Psathyrella magnispora* | Present | Absent | Ellipsoid to broadly ellipsoid | Utriform to (sub)capitate with yellowish thick walls | In chalk grasslands among *Koeleria vallesiana* |

## ACKNOWLEDGEMENTS

We wish to thank Mr. Manfred Enderle (Germany) for his critical revision of the manuscript; to the curator of the L herbarium for the loan of the paratype of *P. badiophylla var. microspora.*

We are also grateful to Mr. J.A. Pérez and A. Priego, from the Servicio de Microscopía Electrónica, Universidad de Alcalá, for their invaluable help with the SEM.

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# STUDY OF SOME SPECIES OF THE GENUS CORTINARIUS, SECTION CAERULESCENTES (R. HENRY) EX MOËNNE-LOCCOZ & REUMAUX IN PENINSULAR SPAIN.

Antonio Ortega(1) & Rafael Mahiques(2)

(1) Dpto. Biología Vegetal, Facultad Ciencias, Universidad Granada, 18071
GRANADA (Spain), e-mail: aortegad@ugr.es
(2) Societat Micologica Valenciana, Dr. Climent 26, 46837 Quatretonda, VALÈNCIA
(Spain). e-mail: rmahiques@eresmas.net

**ABSTRACT**: A study of the complex *Cortinarius caesiostramineus* R. Henry *s. lato* has been made. As a result, we recognize four taxa: *C. caesiostramineus* var. *caesiostramineus, C. caesiostramineus* var. *amarescens* (M.M. Moser) A. Ortega & Mahiques ***comb. et stat. nov.***, *C. caesiostramineus* var. *cadinanos–aguirrae* Moënne-Locc. et A. Ortega, ***var. nova***, and *C. caesiostramineus* var. *gentianeus* (Bidaud) A. Ortega & Mahiques, ***comb. et stat. nov.*** The study has been complemented with *Cortinarius moënne-loccozii* Bidaud and its connections with related taxa such as *C. vaginatopus* Bidaud and *C. volvatus* A.H. Sm.

**KEYWORDS**: *Cortinarius* section *Caerulescentes*, taxonomy, corology.

**INTRODUCTION**: In this paper, we continue other contributions about Spanish taxa of genus *Cortinarius* (e.g. ORTEGA & ESTEVE-RAVENTÓS, 2002, ORTEGA & MAHIQUES, 1995). We draw taxonomic conclusions from the study of some species close to *Cortinarius caesiostramineus* R. Henry and *C. volvatus* A.H Smith. In this study we have analyzed several collections from France, Italy and Spain, more specifically from Spanish mediterranean areas. These mediterranean areas are very interesting, because of their high variability and diversity of fungi; for this reason we find frequent descriptions of new species (e.g. *Cortinarius assiduus* Mahiques et *al.*, *C. ayanamii* A. Ortega et *al.*, *C. erythrofuscus* Mahiques & A. Ortega, etc.).

**MATERIAL AND METHODS**: The field material comes from different areas of the North of Spain, and especially from the Mediterranean region (Andalusia and Valencian Communities); at the same time numerous typical samples from other European countries have been studied, and also some type-collections. The material comes from the following herbaria: Geneva (Switzerland): GK; Innsbruck (Austria): IB; Michigan (USA): MICH; Granada (Spain): GDA, GDAC; Sociedad Micológica de Aranzadi: ARAN-Cort.; private herbarium of R. Mahiques, (Quatretonda, Spain): M.E.S.; private herbarium of Dr. García Bona (Pamplona, Spain): M.N. and private herbarium of P. Moënne-Loccoz (Annecy, France): P.M.L.

Thirty spores of each collection have been measured, in order to calculate the maximum and minimal values, the mean range values and the average value (Xm), as well as the index (Q, Qm) = Quotient or quotient average of length (L) and width (w). When comparing between populations, the method of Simpson & Roy has been applied: $Ic = Xm \pm 1.96\ \sigma/\sqrt{30}$ (BIDAULT, 1968), in order to establish the differences between the sporal mean values (fig 1, 10). The study of the spores under the SEM included in this work (fig 2-9) has been carried out with a Zeiss microscope, DSM 950 model, following techniques applied by MORENO et *al*. (1995).

As basic literature we have used BIDAUD et *al*. (1993, 2000), BRANDRUD et *al*. (1990, 1992), BREITENBACH & KRÄNZLIN (2000) and MOSER (1960).

**SPECIES STUDIED:**

**Cortinarius caesiostramineus** R. Henry, Bull. Soc. Mycol. France 55 (1): 73 (1939) *s. lato*

BIDAUD et *al*. (2000) state that the taxonomic definition of this species has involved a serious difficulty over years because of its variability concerning the size of the spores and also its close affinities to other species, such as *Cortinarius amarescens* M.M. Moser and *Cortinarius gentianeus* Bidaud (= *C. amarescens* s. Kühner).

After having collected numerous samples of *Cortinarius gentianeus* from Andalusia (GDA) and the Valencian Community (MAHIQUES & GUTIERREZ, 2000, M.E.S. 2313), under *Quercus suber* and *Cistus laurifolius*, we decided to make a comparative study with other close taxa (e.g. *C. amarescens* s. *lato*, *C. caesiostramineus* s. *auct. hisp*.) collected and recorded in the Spanish bibliography (e.g. CADIÑANOS, 1996, MAHIQUES, 1999). This has allowed us to establish the possible limits and/or taxonomic relations among them and conclude that in this complex group of taxa we can recognize the following.

***Cortinarius caesiostramineus*** var. ***amarescens*** (M.M. Moser) A. Ortega & Mahiques, ***comb. et stat. nov***.

Basion.: *Phlegmacium amarescens* M.M. Moser, *Die Gattung Phlegmacium*: 351 (1960).
= *Cortinarius caesiostramineus* R. Henry *sensu* Brandrud et *al*. (1990), Cadiñanos (1996),. Mahiques (1999), non *sensu* Bidaud et *al*. (2000) (= *C. caesiostramineus* var. *caesiostramineus*).

**Ico. Sel**.: BRANDRUD et *al*. (1990).

**Studied material**: SWITZERLAND: Kt. Bern, Lanenbach, Brienz, under *Picea*/*Fagus*, 16.10.1999, Leg. J. Gilgen (Det. M.M. Moser), IB 1999/0244. FRANCE: Pralognan, Fôret d'Isertan, under Nadelwald, 20.9.1971, leg. M.M. Moser, IB 71/166, ITALY: Trentino, Alpe Lucia bei Paneveggio, *Picea*, *Larix* zw. Moos und Nadelstreu, 10.9.1996, leg. M.M. Moser, IB 1996/0105. SPAIN: Castelló, Alt Palància, Pina del Montalgrao, Ombria de Sta. Bárbara, 1200m., under *Pinus pinaster* and *P. sylvestris*, 15.10.1999, leg. R. Mahiques, M.E.S. 3484 (MAHIQUES, 1999 sub *C.*

*caesiostramineus*). *Ibidem*, L'Alcalatén, Penyagolosa, Vistabella del Maestrat, Capçalera del Barranc de l'Esquilador, 1330m., under *P. sylvestris*, 16.10.1999, leg. A. Conca, M.E.S. 3457 (MAHIQUES, 1999, sub *C. caesiostramineus*).

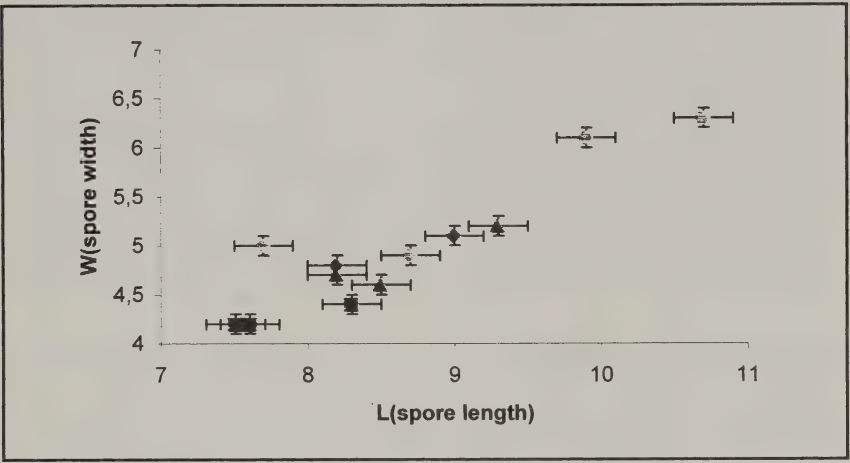

Figure 1. The intervale of confidence of the mean values of L, W: *Cortinarius caesiostramineus* var. *amarescens* Herb. IB (▲), Herb. M.E.S.(♦). C. *caesiostramineus* var. *cadinanos-aguirrae* (●). C. *caesiostramineus* var. *gentianeus* (■).

**Description**: The macroscopic description has been compiled from the data provided by CADIÑANOS (1996) and MAHIQUES (1999). Pileus 33-55 mm, convex, plano-convex or applanate, whitish, whitish cream, buff, with some bluish gray tones (MAHIQUES, 1999), which soon turns into pale ochre; cuticle viscid, without radial fibrils and with small white veil remains, of satiny-glazed aspect , more obvious in the disk. Lamellae crowded, emarginate, pale cream with very evanescent pink lilac shades, that turn into cream ochraceous and finally to tobacco brown. Stipe 40-61 x 8-14 (- 18) mm, white, with some lilac hues at the apex (CADIÑANOS, 1996), cylindrical, broadened in a marginately bulb (16-26 mm) hardly prominent. Context white, bitterish in the pileus and strongly bitter in the cap cuticle. Negative reaction with KOH and NH3.

Spores (Fig. 2, 3) of 7.5-10.5 x 4-6 µm, mean values 8.2-9.3 x 4.6-5.2 µm (Xm = 8.7 x 4.9 µm), Q: L/w = 1.6-2, mean values 1.74-1.85, (Qm = 1.79), yellowish, almond-shaped to lemon-shaped, with sub-smooth to low ornamentation, formed by isolated or hardly interconnected warts.

**Observations**: Some authors (e.g. BRANDRUD et *al*., 1990; CADIÑANOS, 1996;

MAHIQUES, 1999) consider *C. caesiostramineus* and *C. amarescens* conspecific, however for other mycologists (e.g. BIDAUD et *al.*, 2000) they represent different species according to the following characteristics:

(1) Distinct bluish or violet colour in the pileus of *C. caesiostramineus.*

(2) Context yellow with KOH and green with NO3Ag of *C. caesiostramineus.*

(3) Specific habitat under *Picea abies* of *C. caesiostramineus.*

However, if we analyze closely these characters, we can accept that their taxonomic value is not significant, since (1) the presence or absence of violet-bluish colours on the basidiocarp is not a character very stable in section *Caerulescentes* (MELOT, 1990); (2) the reaction of the flesh with KOH and NO3Ag has only been observed by BIDAUD et *al.* (2000), and is not described in the original description of HENRY (1939); (3) some typical collections of *C. amarescens* (e.g. IB 1999/0244) have also been gathered in mixed woods of *Picea* and *Fagus*. For these reasons, we do not agree with the separation of *C. amarescens* and *C. caesiostramineus* at specific range; we better consider -as also indicated by BIDAUD et *al.* (*op. cit*: 68) and BRANDRUD et *al.* (1992: 13)- a differentiation of two varieties: *Cortinarius caesiostramineus* var. *caesiostramineus* (= *C. caesiostramineus* s. Bidaud et *al.*, 2000) and *Cortinarius caesiostramineus* var. *amarescens* (= *C. caesiostramineus* s. Brandrud et *al.*, 1990).

***Cortinarius caesiostramineus*** var. ***cadinanos-aguirrae*** Moënne-Locc. & A. Ortega, ***var. nov.***

**Etymology**: Dedicated to J.A. Cadiñanos Aguirre for his study focused on *Cortinarius* in the Basque Country.
= *Cortinarius amarescens* M.M. Moser, *sensu*. Bidaud et *al.* (1993) *pro parte*, Cadiñanos (1996) *pro parte*, Marchand (1982) *pro parte*.

**Studied material**: FRANCE: Bois de Beyne, Ile de France, under broadleaved trees, oct.1979, P.M.L. 2769 (*paratypus*). SPAIN: Burgos, Barrasa de Mena, under *Quercus faginea*, 20.11.1999, leg. J.A. Cadiñanos. GDA 44814 (*holotypus*).

*Basidiomata Cortinarius caesiostramineus* var. *amarescens similis. Sporae* 9-11.2 x 5.5-7 µm. *Hispania, Burgos, Barrasa de Mena, in Querci faginea silva, leg. J.A. Cadiñanos, holotypus in herbario GDA 44814.*

**Observations**: The distinctive characters of this taxon, which is macroscopically quite similar to *C. amarescens* (BIDAUD et *al.*, 1993: 135) are: (1) its habitat in broad-leaved forests ) and, (2) its spores (Fig. 4) lemon-shaped – almond-shaped (Q :L/w = 1.5-1.9, Qm = 1.67) of (8.8 -) 9-11 (- 11.2) x 5.5-6.8 (-7) µm (mean values 9.9-10.7 x 6.1-6.3 µm, Xm= 10.3 x 6.2 µm), whereas in *C. caesiostramineus* var. *amarescens* the spores, though morphologically similar (Fig. 3), are smaller (Fig. 1), measuring: 7.5-10.5 x 4-6 µm (mean values 8.2-9.3 x 4.6-5.2 µm, Xm= 8.7 x 4.9 µm).

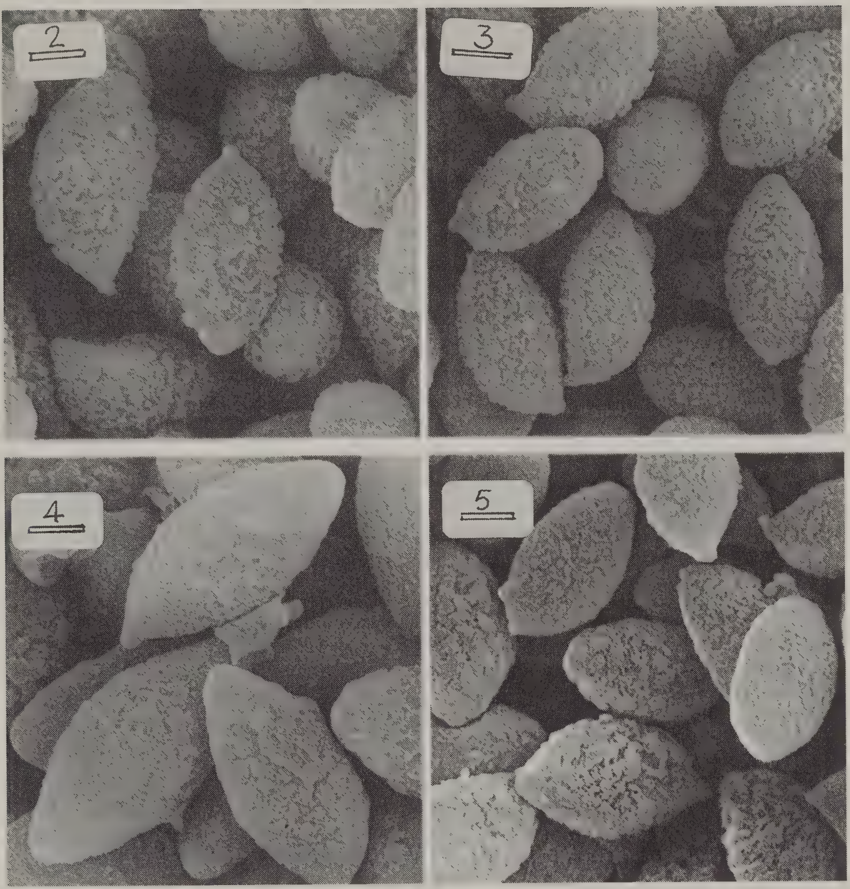

Figure 2: *Cortinarius caesiostramineus* var. *amarescens* (M.E.S. 3484). Fig. 3: *C. caesiostramineus* var. *amarescens* (IB 1996/ 0105). Fig. 4: *C. caesiostramineus* var. *cadinanos-aguirrae* (holotypus). Fig. 5: C. *caesiostramineus* var. *gentianeus* (GDA 44813). (Bar: 2µm).

***Cortinarius caesiostramineus*** R. Henry. var. ***caesiostramineus***, Bull. Soc. Mycol. France 55 (1): 73 (1939)

= *Cortinarius caesiostramineus* R. Henry, *sensu* Bidaud et *al*. (2000), non Brandrud et *al*. (1990).

**Desc. et Icon. Sel**. : BIDAUD et *al*. (2000).

***Cortinarius caesiostramineus*** var. ***gentianeus*** (Bidaud) A. Ortega & Mahiques, ***comb. et stat. nov.***

Basion.: *Cortinarius gentianeus* Bidaud in Bidaud et *al*., Atlas des Cortinaires, pars V: 150 (1993)
= *Cortinarius amarescens* M.M. Moser, *sensu* Kühner

**Icon. Sel**.: BIDAUD et *al*. (1993), CONSIGLIO (1995), MAHIQUES & GUTIERREZ (2000).

**Studied material**: SPAIN: Castelló, Artana, under *Quercus suber*, 17.11.1997, leg. A. Burguete, M.E.S. 2313 (MAHIQUES & GUTIÉRREZ, 2000). Jaén, Santa Elena, Miranda del Rey, under *Quercus suber* and *Cistus ladanifer*, 27.11.1999, leg. J.D. Reyes, GDA 44813.

**Description**: Pileus 4-8 cm width, hemispheric to flat -convex, whitish cream, with pink hues in some specimen, then ochraceous, cuticle viscous and peeling off, bitter. Lamellae emarginate, crowded, pale colour, with violet hues when young, becoming cream or buff. Stipe 5-7 x 1.8-2.2 cm cylindrical, with marginated bulb 3.5-4 cm, broad coated with abundant membranous volviform remains, at first whitish with the apex lilac-bluish, then ochraceous. Context bitter, whitish, slightly bluish at the apex of the stipe, yellowish cream in the bulb. Spores (Fig. 5) 6.5-9 (- 10) x (3.5 -) 4-5 µm, mean values 7.6-8.3 x 4.4 µm (Xm = 7.9 x 4.4 µm), Q: L/w = (1.5 -) 1.55-2.2, mean values 1.72-1.89 (Qm = 1.8), yellowish, ellipsoid to subellipsoid or subalmond-shaped, with soft ornamentation, mainly constituted by isolated warts.

**Distribution**: It does not seem to be a common species in Spain. In Europe it is known from France (BIDAUD et *al*., 1993) and Italy (CONSIGLIO, 1995).

**Observations**: This taxon shows close affinities to *Cortinarius caesiostramineus* var. *amarescens,* which seems to grow almost exclusively in coniferous forests, for that reason *Cortinarius gentianeus* Bidaud could represent an analogous taxon in broad-leaved forests. *C. caesiostramineus* var. *amarescens* shows a more slender stipe (up to 1'5 cm thick) and the spores are amygdaliform or, more frequently, sublemon-shaped (Fig. 3), and bigger (Fig. 1) (mean values 8.2 –9.3 x 4.6-5.2 µm); *C. caesisotramineus* var. *gentianeus* shows a broader stipe (up to 2.2 cm) and the spores are ellipsoid to subalmond-shaped or subellipsoid (Fig. 5) and smaller (Fig. 1) (mean values 7.5-8.3 x 4.2-4.4 µm). Consequently, we believe that it is reasonable to treat *C. caesiostramineus* var. *amarescens* and *Cortinarius caesiostramineus* var. *gentianeus* as two different varieties which grow in coniferous and broadleaved trees respectively. Also some overlapping in spore values of both taxa are observed. The spore size is the only character used by BIDAUD et *al*. (1993) to separate both at specific level, but this has been revealed to be untenable. In addition, there is a strong variability in spore size of *Cortinarius amarescens* s. *lato* as some authors have previously indicated (e.g. MARCHAND, 1982: 223).

***Cortinarius moenne-loccozii*** Bidaud in Bidaud et *al.*, Atlas des Cortinaires, pars V: 151 (1993)

= *Cortinarius volvatus* A.H. Smith *sensu* Lazzari & Bellu (1985), Cetto (1993)
= *Cortinarius vaginatopus* Bidaud et *al.* (1993) ?

**Icon. Sel.:** BIDAUD et *al.* (1993), BREITENBACH & KRÄNZLIN (2000), CETTO (1993), CONSIGLIO (1996).

**Studied material**: SPAIN: Granada, Arroyo de Fardes, Natural Park of the Sierra de Huétor, under *Quercus faginea* and Q. *ilex* subsp. *ballota*, 10.10.1996, leg. A. Capilla, GDAC 42717. Barcelona, Serra de l'Arca, Seva (Osona), mixed forest of *Quercus ilex* and *Pinus* sp., 2.11.1991, leg. Gutiérrez. (GUTIÉRREZ & MAHIQUES, 1999). *Ibidem*, Cantomigrós, oak wood (Quercus pubescens?), in eutrophic soil or a little acid, 18.10.1999. Leg. J.A. Cadiñanos, ARAN-Cort. Navarra: Elzaburu, in oak wood, between fallen leaves, 31.10.1987, leg. García Bona, M.N. 3134. (GARCÍA BONA, 1994 as *Cortinarius volvatus* A.H. Smith). Alava, puerto de Altube, beech wood eutrophic or a little acid, 12.10.1994, Leg. J.A. Cadiñanos, ARAN-Cort. *Ibidem*, Ondátegui, Zigoitia, under *Quercus faginea* and *Quercus robur*, in neutral or calcicolous soil, 12.10.1994, Leg J.A.Cadiñanos, ARANZ-Cort. FRANCE: Face west of the Desit-du-Chat a Meyzieu-Tronet (Savoie), near a acid wood with grass layer (heathland) with *Quercus* sp., *Acer* sp., *Betula* sp. et *Populus tremula*, 20.10.1991, leg. A. Bidaud, GK 416908 (*holotypus*).

**Studied material for comparison**: *Cortinarius vaginatopus* Bidaud & al.: FRANCE: Neufchef (Moselle), beech-forest in thermophilous clay calcareous soil, 27.8.1989, leg. G. Trichies, GK 416912 (*holotypus*). *Cortinarius volvatus* A.H. Smith: USA: California, Crescent City, under spruce, 18.11.1937, leg. A.H. Smith, MICH (A.H. Smith) 8857 (*holotypus*). *Ibidem*, 5.11.1937, MICH (A.H. Smith) 8457, *Ibidem*, under *Picea*, 5.11.1937, MICH (A.H. Smith) 8457, IB 1937/28, *Ibidem*, under spruce, 3.11.1937, MICH (A.H. Smith) 8359, Fort Dick, under spruce, 11.10.1937, MICH (A.H. Smith) 8599, Mendocino Co., Russian Gulch State PK., under Tsuga, Pseudotsuga and Sequoia, 30.11.1991, leg. M.M. Moser, IB 91/613.

**Description**: The macroscopic description has been taken from fresh material or from data provided by other authors (e.g. GARCÍA BONA, 1994, GUTIÉRREZ & MAHIQUES, 1999, etc.), which we have been studying. The spore size is referred to Spanish material and also to type material.

Pileus 4-9.5 (-11) cm diam., dark blue, grey bluish, violet-lilaceous, grey violet, turning into pale grey lilac or lilac pink, fading at the end loosing the bluish hue, violet or lilac; hemispherical convex, then flat-convex, with the edge strongly recurved when young; surface viscid, with radial innate fibrils, more or less evident, but always more distinct to the periphery; universal veil distinct, white or yellowish ochraceous forming membranous remnants, "sometimes so copious that reminds of an *Amanita* (GARCÍA BONA, 1994)". Stipe 4-9 (-11) x 0.7-2.3 cm cylindric, with bulb conspicuously marginated (x 1.5-4 cm), concolorous or paler than the pileus, although, quickly turning yellowish ochraceous from the bulb, distinct basal volva that wraps all the bulb or even exceeds it, white, yellowing or browning with age. Lamellae adnate or emarginate, crowded, at first concolorous with pileus or lilac, immediately turning cream ochraceous or ochraceous.

Spore (fig. 7, 8) 8.2-10.5 (-11) x (4.5-) 5-6.2 µm, mean values 9.1-10.2 x 5.3-5.7 µm (Xm = 9.7 x 5.5 µm), almond-shaped, sublemon-shaped o lemon-shaped, with moderate or coarse ornamentation, formed by more o less anastomosing warts.

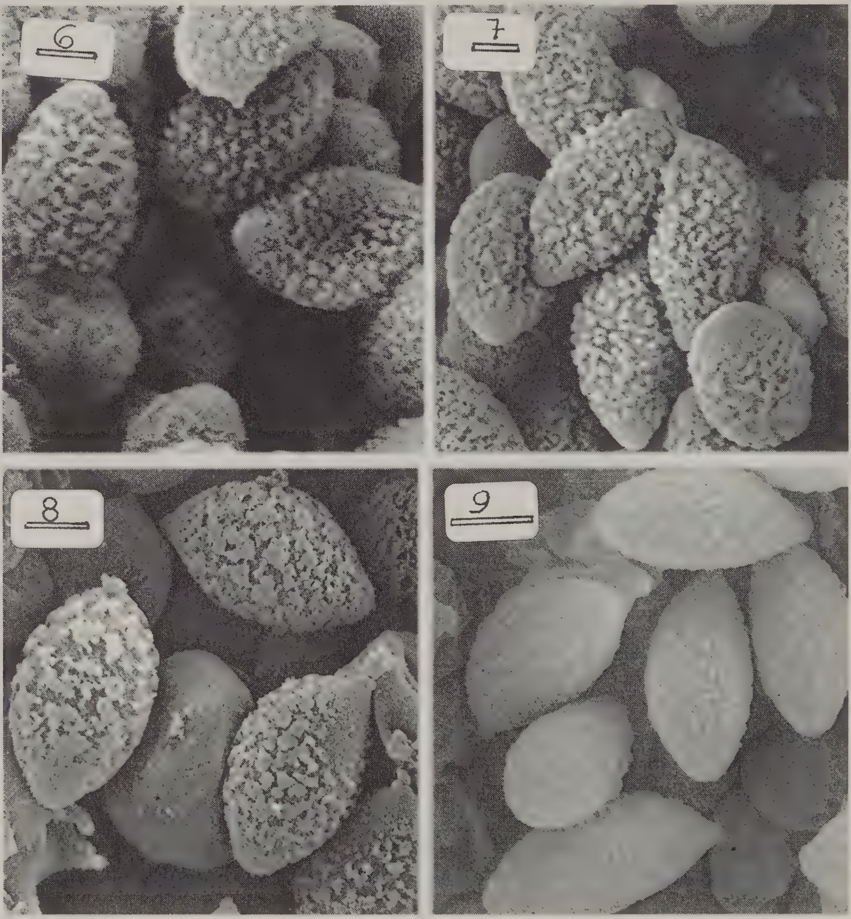

Figure 6: *Cortinarius volvatus* (holotype). Fig. 7: *C. moenne-loccozii* (holotype). Fig. 8: *C. moenne-loccozii* (GDAC 42717). Fig. 9: *C. vaginatopus* (holotype). (Bar: 2 µm).

**Distribution**: It is a frequent taxon in Spain and its presence is known from the Basque Country (CADIÑANOS, 1998), Navarra (GARCÍA BONA, 1994, as *C. volvatus*), Catalonia (GUTIÉRREZ & MAHIQUES, 1999) and now in Andalusia, as well as in other European Countries like France (BIDAUD et *al*., 1993), Italy (CONSIGLIO, 1996, CETTO, 1993 as *C. volvatus* and LAZZARI & BELLÙ, 1985 as *C. volvatus*) and Switzerland (BREITENBACH & KRÄNZLIN, 2000 and FRELECHOUX, 1995).

**Discussion**: In spite of the intense study on *Cortinarius moënne-loccozii* Bidaud carried out by FRELECHOUX (1995), where the distinction from other close species like *Cortinarius volvatus* A.H. Smith or *Cortinarius vaginatopus* Bidaud et *al*. is discussed, we think that the separation between this three taxa, especially in the case of *C. vaginatopus*, is really difficult, if we take into account the great variability in colour ( especially of the pileus) of many species of *Phlegmacium*. This problem becomes obvious in the section *Caerulescentes*, as MELOT (1990) has pointed out (depending of the degree of development on basidiomata, bioclimatic peculiarities, etc). We believe that the character should not be overemphasized in separating different species. Likewise other macroscopical (e.g. presence of radial fibrils on the pileus surface, degree of development, colour of remnants of universal veil on pileal surface, colour of context, etc.) and even microscopical characters (e.g. basidia size), explained by FRELECHOUX (1995) and BIDAUD et *al*. (1993), seem too variable, as we have obseved in the Spanish collections belonging to the complex.

The only feature which we consider of taxonomic value referres to morphology and spore size. We have carried out the study of the sporal peculiarities of *C. moënne-loccozii* (Fig. 7, 8), *C. vaginatopus* (Fig. 9) and *C. volvatus* (Fig. 6), that has allowed us to conclude the following:

(1) *Cortinarius moënne-loccozii* shows almond-shaped to lemon-shaped spores, with moderate or coarse warts, 9.1-10.5 x 5.3-5.8 µm; Q : L/w = 1.67-1.86 (mean values). *Cortinarius vaginatopus* has almond-shaped to lemon-shaped spores, with moderate ornamentation, 9-9.3 x 4.9-5 µm; Q : L/w = 1.84-1.86 (mean values). In *Cortinarius volvatus* the spores are almond-shaped to lemon-shaped with smooth to moderate ornamentation, 7.8-8.6 x 4.7-5.4 µm; Q: L/w = 1.55-1.75 (mean values). As it can be noted, there are not clear differences in sporal size (Fig. 10), not even in sporal shape. Some Spanish collections of *Cortinarius moënne-loccozi* (e.g. GDAC, ARANZ-Cort., etc.) show spores significantly smaller than observed by BIDAUD et *al*. (1993) and FRELECHOUX (1995), close to the sporal size of *Cortinarius vaginatopus* and even of *Cortinarius volvatus*.

(2) The present level of knowledge about the variability of *Cortinarius vaginatopus* Bidaud et *al*. (= C. *volvatus* s. Moser, 1960 Marchand. 1982) is very poor, because up to now it has been only published data about type material and some other doubtful collection studied by FRELECHOUX (1995); in our opinion, it is not advisable to separate -at specific level- this taxon from *Cortinarius moënne-loccozi*, as there is a clear overlapping in the sporal values of both species (MOSER, 1960, MARCHAND, 1982). This situation is the same in the case of *C. vaginatopus* and *C. volvatus s. Smith,* as far a we know, the sporal measure of the last species are 7-9 (-9.5) x 4.5-5.5 (-5.8) µm; Q: L/w = 1.4-1.9, overlapping therefore with the sporal value of *C. vaginatopus*, for

that reason the separation between these taxa does not seem clear.

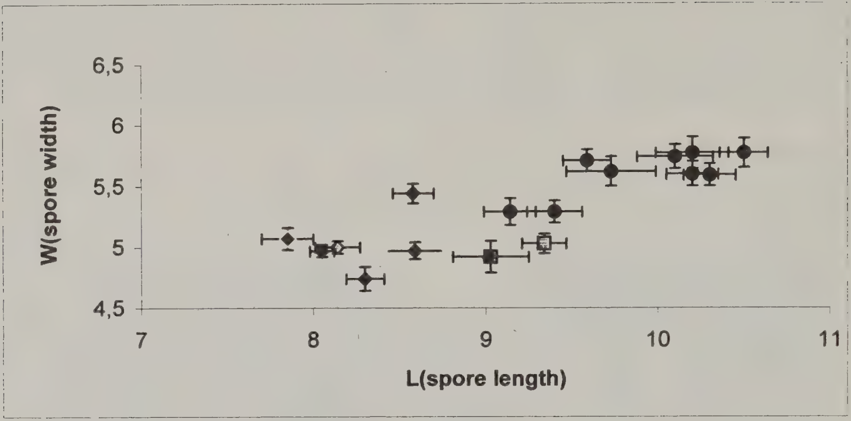

Figure 10: The intervales of confidence of the mean values of L, W: *Cortinarius moenne-loccozzi* (●). *C. vaginatopus* (■). *C. volvatus* (♦).

(3) As a consequence of what has been exposed in paragraphs one and two, we believe that is the separation of the two species is acceptable:

*Cortinarius volvatus* A.H. Smith : it grows in coniferous forests, has a paler pileus (blue or grayish violet), smaller spores (mean values 7.8-9 x 4.7-5.4 µm), less markedly lemon-shaped (sublemon-shaped to lemon-shaped) and with lower ornamentation.

*Cortinarius moënne-loccozii* Bidaud (= *Cortinarius vaginatopus* Bidaud et *al.*?): it grows under broad-leaved trees, has a deeper pileus colour with larger spores (value means 9.1-10.5 x 5-5.8 µm), markedly lemon-shaped and coarser ornamentation.

As for *Cortinarius vaginatopus* Bidaud et *al.*, we believe that it would be appropiate to study new collections in order to establish clear differences with *C. moënne-loccozii.*

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# ROZITES, CUPHOCYBE AND RAPACEA ARE TAXONOMIC SYNONYMS OF CORTINARIUS: NEW COMBINATIONS AND NEW NAMES

Ursula Peintner[1, 3], Egon Horak[2], Meinhard Moser[3] and Rytas Vilgalys[1]

[1]Institute of Biology, Duke University, Durham, NC 27709, USA
[2]Geobotanical Institute, ETHZ, Zollikerstr. 107, CH-8008 Zürich, Switzerland
[3]Institute of Microbiology, University of Innsbruck, Technikerstr. 25,
A-6020 Innsbruck, Austria; ursula.peintner@uibk.ac.at

**Abstract** Results of recent molecular phylogenetic studies using rDNA sequences of ITS and LSU showed that *Rozites* is nested within *Cortinarius* and polyphyletic. *Rozites* spp. were delimited from *Cortinarius* spp. by having both a membranaecous universal veil and a membranaceous partial veil in the form of a persistent annulus. However, molecular studies suggest that membranaceous veils have independently evolved several times in the genus *Cortinarius*. *Cuphocybe* and *Rapacea* are also nested within *Cortinarius*, making the latter genus paraphyletic. The morphological delimitation of all these genera is critical: *Cuphocye* spp. lack an annulus or cortina, but have pigmented veil fibrils or scales; the monotypic genus *Rapacea* accommodates a taxon macroscopically resembling *Cortinarius* spp., but with pale, nearly smooth and thick-walled basidiospores. In order to acknowledge the phylogenetic relationships and the given morphological transitions between these genera and *Cortinarius*, we recommend synonymizing *Rozites, Cuphocybe* and *Rapacea* with *Cortinarius*, making 16 new combinations and providing 10 new names, which became necessary due to homonyms.

***Key words***: Agaricales, Cortinariaceae, nomenclature

## Introduction

The genus *Rozites* P. Karst. 1879 was erected to accommodate *Cortinarius caperatus* (Pers.: Fr.) Fr., a species with a conspicuous, double veil. More than 20 species of *Rozites* are currently recognized; most of them were described from the Southern Hemisphere during the last 20 years (Horak 1981; Horak & Taylor 1981, Halling & Ovrebo 1987, Bougher et al. 1994). Currently the genus *Rozites* circumscribes species with a membranaceous partial veil in form of a persistent, smooth or striate ring, and additionally with a membranaceous universal veil. However, the latter can often consist only of inconspicuous scales or squamules covering the surface of the pileus and the inferior part of the stipe (Horak 1968, Horak & Taylor 1981, Singer 1986). Such morphological transitions make a morphology based delimitation of *Cortinarius* and *Rozites* difficult, as many *Cortinarius* species with a membranaceous annulus or with a volva have been described, especially from the Southern Hemisphere (Moser & Horak 1975; Horak 1981; Bougher & Hilton 1989; Horak & Wood 1990; Bougher & Syme 1998).

Also the boundaries between *Cuphocybe* Heim 1951 and *Rozites* are indistinct, and restricted to veil characters: the absence of an annulus is the main morphological character separating these genera. Furthermore, *Cuphocye* is characterized by pigmented veil fibrils or scales and by the lack of a cortina (Heim 1951, Horak 1973, Singer 1986, Soop 1998). To date, six species of *Cuphocybe* have been described from New Zealand or China (Heim 1951, Horak 1973, 1980, Soop 1998, Zang 1987).

Recently, another new genus occurring in New Zealand, Tasmania and Papua New Guinea was described: *Rapacea* E. Horak 1999 (Horak 1999). This monotypic genus was erected to accommodate *R. mariae* E. Horak 1999, a taxon that closely resembles members of *Cortinarius* stirps *Cystidiorapaceus* (Moser and Horak 1975). *Rapacea mariae* is characterized by thick-walled basidiospores that appear smooth when observed by light microscopy but which are minutely asperulate when examined by scanning electron microscopy (SEM). Furthermore, the color of the spore print of *R. mariae* is olive and not rusty brown as typical for the majority of *Cortinarius* spp. (Horak 1999).

Recent molecular phlylogenetic studies using sequences of the rDNA internal transcribed spacers (ITS) and of the large subunit (LSU) demonstrated that the genera *Rozites, Cuphocybe* and *Rapacea* cannot be regarded as independent, monophyletic lineages, but are all nested within the genus *Cortinarius* (Peintner et al. 2001, Peintner et al. 2002). They are either polyphyletic, and/or closely related to typical *Cortinarius* spp. Thus, the evolution of different veil types, e.g. membranaceous annuli, occurred independently several times within *Cortinarius*. The genera *Rozites, Cuphocybe* and *Rapacea* are artificial and do not reflect natural relationships. Also morphologically these genera cannot be clearly delimited from *Cortinarius*. In order to acknowledge the phylogenetic relationships as well as the given morphological transitions between these genera and *Cortinarius*, we propose to synonymize the genera *Rozites, Cuphocybe* and *Rapacea* with *Cortinarius*.

## Correct names, new names and proposed combinations

*Cortinarius achrous* E. Horak, Peintner, M.M. Moser & Vilgalys nom. nov. Basionym: *Rozites pallida* E. Horak & M.W. Taylor 1981: N Z J Bot 19: 356, non *Cortinarius pallidus* Peck 1889, non *Phlegmacium pallidum* M.M. Moser 1960.

*Cortinarius alboroseus* (R. Heim) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Cuphocybe alborosea* R. Heim 1951: Rev. Mycol. 16: 8.

*Cortinarius armeniacovelatus* (Bougher, Fuhrer & E. Horak) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites armeniacovelata* Bougher, Fuhrer & E. Horak 1994: Aust. Syst. Bot. 7: 357-359.

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*Cortinarius austropacificus* E. Horak, Peintner, M.M. Moser & Vilgalys nom. nov. Basionym: *Rozites neocaledonica* E. Horak 1981: Sydowia 34: 10, non *Cortinarius neocaledonicus* E. Horak 1990.

*Cortinarius badioferrugineus* E. Horak, Peintner, M.M. Moser & Vilgalys nom. nov. Basionym: *Cuphocybe ferruginea* E. Horak 1980: Sydowia 33: 60, non *Cortinarius ferrugineus* (Scop. : Fr.) Fr. 1838.

*Cortinarius calosporus* (M. Zang) Peintner, M.M. Moser, E. Horak, & Vilgalys comb. nov. Basionym: *Cuphocybe calospora* M. Zang 1987: Act. Bot. Yunnanica 9(1): 82.

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*Cortinarius colombianus* (Halling & Ovrebo) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites colombiana* Halling & Ovrebo 1987: Mycologia 79: 674.

*Cortinarius dulciolens* E. Horak, M.M. Moser, Peintner, & Vilgalys nom. nov. Basionym: *Cuphocybe melliolens* Soop 1998: Doc. Mycol. 28 (112): 22, non *Cortinarius melliolens* Jul. Schaeff. ex P.D. Orton 1960.

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*Cortinarius elaiochrous* E. Horak, M.M. Moser, Peintner, & Vilgalys nom. nov. Basionym: *Cuphocybe olivacea* R. Heim 1951: Rev. Mycol. 16: 8, non *Cortinarius olivaceus* Peck 1872.

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*Cortinarius emodensis* var. *vinacea* (Z.-L. Yang) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites emodensis* var. *vinacea* Z.-L. Yang 1998: Fung. Sci. 13: 64.

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*Cortinarius meleagris* (E. Horak & M.W. Taylor) E. Horak, Peintner, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites meleagris* E. Horak & M.W. Taylor 1981: N Z J Bot 19: 354.

*Cortinarius metallicus* (Bougher, Fuhrer & E. Horak) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites metallica* Bougher, Fuhrer & E. Horak 1994: Aust. Syst. Bot. 7: 355.

*Cortinarius obtectus* Peintner, E. Horak, M.M. Moser & Vilgalys nom. nov. Basionym: *Rozites occulta* Bougher, Fuhrer & E. Horak 1994: Aust. Syst. Bot. 7: 363, non *Cortinarius occultus* Moënne-Locc. & Reumaux 1996.

*Cortinarius ochraceoazureus* (E. Horak) E. Horak, M.M. Moser, Peintner & Vilgalys comb. nov. Basionym: *Thaxterogaster ochraceoazureus* E. Horak in Moser & Horak 1965: Nova Hedwigia, Beih. 10: 237. Synonym: *Rozites ochraceoazurea* (E. Horak) E. Horak 1980; *Cortinarius ochroianthinus* E. Horak & M.M. Moser in Moser & Horak 1975: Nova Hedwigia, Beih. 52: 274: *Cortinarius gliocyclus* E. Horak in Moser & Horak 1975: Nova Hedwigia, Beih. 52: 275.

*Cortinarius perfoetens* E. Horak, Peintner, M.M. Moser & Vilgalys nom. nov. Basionym: *Rozites foetens* Bougher, Fuhrer & E. Horak 1994: Aust. Syst. Bot. 7: 359, non *Cortinarius foetens* (M.M. Moser 1960) M.M. Moser 1967.

*Cortinarius phaeomyxa* (E. Horak) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Cuphocybe phaeomyxa* E. Horak 1973: Beih. Nova Hedwigia 43: 198

*Cortinarius phaleratus* (Fr.) Peintner, M.M. Moser E. Horak, & Vilgalys comb. nov. Basionym: *Agaricus phaleratus* Fr. 1838, Epicrisis systematis mycologici (Uppsala): 169. Synonym: *Rozites phaleratus* (Fr.) Bon & Ramm 1994, Doc. Mycol. 23(92): 46.

*Cortinarius purpurellus* M.M. Moser, E. Horak, Peintner, & Vilgalys nom. nov. Basionym: *Rozites violacea* E. Horak in Moser & Horak 1975: Nova Hedwigia, Beih. 52: 516. Synonym: *Rozites purpurea* M.M. Moser in Moser & Horak 1975: Nova Hedwigia, Beih. 52: 514, non *Cortinarius violaceus* (L.: Fr.) Fr. 1838, non *C. purpureus* (Bull.) Bidaud, Moënne-Locc. & Reumaux 1994.

*Cortinarius roseolilacinus* (Bougher, Fuhrer & E. Horak) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites roseolilacina* Bougher, Fuhrer & E. Horak 1994: Aust. Syst. Bot. 7: 356-366.

*Cortinarius rugosiceps* (E. Horak & M.W. Taylor) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites rugosiceps* E. Horak & M.W. Taylor 1981: N Z J Bot 19: 357.

*Cortinarius sarmienti* Speg. 1887: Bol. Ac. Nac. Ciencias Cordoba 11: 151. Synonym: *Rozites sarmienti* (Speg.) E. Horak 1980; *Cortinarius togularis* E. Horak in Moser & Horak 1975: Nova Hedwigia, Beih. 52: 277.

*Cortinarius similis* (E. Horak) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites similis* E. Horak 1981: Sydowia 34: 98.

*Cortinarius subcastanella* E. Horak, Peintner, M.M. Moser & Vilgalys nom. nov. Basionym: *Rozites castanella* E. Horak & M.W. Taylor 1981: N Z J Bot 19: 358, non *Cortinarius castanellus* Peck 1878.

*Cortinarius symeae* (Bougher, Fuhrer & E. Horak) Peintner, E. Horak, M.M. Moser & Vilgalys comb. nov. Basionym: *Rozites symeae* Bougher, Fuhrer & E. Horak 1994: Aust. Syst. Bot. 7: 361.

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# PRELIMINARY CHECKLIST OF AGARICALES FROM CROATIA. II.
# FAMILIES AGARICACEAE, AMANITACEAE, CORTINARIACEAE AND HYGROPHORACEAE.

ARMIN MEŠIĆ & ZDENKO TKALČEC

Laboratory of Biocoenotical Research
Department of Molecular Genetics
Ruđer Bošković Institute
Bijenička cesta 54, 10000 Zagreb, Croatia
E-mail: armin.mesic@zg.hinet.hr
E-mail: zdenko.tkalcec@zg.tel.hr

## ABSTRACT

The second part of the preliminary checklist of Agaricales from Croatia is given. It comprises the families Agaricaceae, Amanitaceae, Cortinariaceae and Hygrophoraceae. 244 species belonging to 21 genera are presented. One genus and 38 species are reported for the first time from Croatia. For each species, the published and unpublished sources of data are given, as well as the collections in which the material is deposited.

**Key words:** Basidiomycota, biodiversity, mycoflora, bibliography.

## INTRODUCTION

This is the second part of the preliminary checklist of Agaricales from Croatia. It comprises the families Agaricaceae, Amanitaceae, Cortinariaceae and Hygrophoraceae. The checklist includes data published or collected before 1 January 2000. Information about the geographical and biogeographical position of Croatia, material, methods and presentation are given in the first part of the checklist (Tkalčec & Mešić 2002).

In this paper we present 244 species belonging to 21 genera found on the territory of Croatia, of which we have revised 113 species. Out of the overall number 49 species belong to the family Agaricaceae, 32 species to the family Amanitaceae, 111 species to the family Cortinariaceae, and 52 species to the family Hygrophoraceae. One genus and 38 species are reported for the first time from Croatia.

**Marks and abbreviations:**

* - taxon reported for the first time from Croatia in this paper;
• - at least part of records of taxon revised;
(1) - number in brackets indicates synonym or misapplied name under which the author of the record has quoted taxon;
( ) - empty brackets indicate that the author of the record has also quoted the taxon under the name we use;
? - (a) question mark instead of an author of combination means that we could not find the author in the literature available to us; (b) question mark following the source of a published record or abbreviation of a collection means that the author himself doubted his original identification;
= **?** - taxon not found in modern taxonomic literature;
Exs. - collections in which the dried material (exsiccatum) is deposited;
HR? - taxon most probably found in the territory of Croatia (locality not precisely quoted);
Incl. - including;
Lit. - literature;
Misappl. - misapplied name;
Ref. - references (sources of records of taxon);
rev. - revised (when we have revised records of other authors);
unp. - unpublished data.

## SURVEY OF TAXA

### Familia **Agaricaceae** Fr.

***Agaricus*** L. : Fr. emend. P. Karst.

(Lit.: Arnolds *& al.* 1995, Bohus 1990, Bollmann *& al.* 1996, Bon 1985, Cappelli 1984, Hansen & Knudsen 1992, Heinemann 1977, Kreisel 1987, Moser 1983, Noordeloos *& al.* 2001, Pilát 1951 a, Singer 1986)

***Agaricus albosericeus*** Rauschert
= *Agaricus aestivalis* (F.H. Møller) Pilát (nom. illeg.) non *A. aestivalis* Schumach. (1)
Ref.: Focht 1974 (1)

***Agaricus annae*** Pilát
= *Agaricus sylvaticus* Schaeff. : Fr. var. *pallens* Pilát (1)
Ref.: Barčić 1996 (1)

***Agaricus arvensis*** Schaeff.
= *Psalliota arvensis* (Schaeff.) P. Kumm. (1)
Ref.: Blagaić 1921 (1), Blagaić 1931 (1), Gjurašin 1898 (1), Lisiewska & Tortić 1990, Lorinser - Janda 1877 (1), Mužic & Božac 1984, Mužic & Božac 1997, Tortić 1964, unp. Tortić ( )(1), Schulzer 1857 HR?

•***Agaricus augustus*** Fr.
= *Agaricus augustus* Fr. var. *albus* Moser (nom. illeg.) (1)
= *Agaricus bresadolae* (Schulzer) Sacc. (nom. illeg.) (2)
= *Psalliota bresadolae* Schulzer (nom. illeg.) (3)
= *Agaricus perrarus* Schulzer (4)
= *Psalliota perrara* (Schulzer) Bres. (5)
= *Agaricus augustus* Fr. var. *perrarus* (Schulzer) Bon et Cappelli
Ref.: Blagaić 1931 (5), Focht 1974 (1), Schulzer 1880 (4), Schulzer 1885 (3), Schulzer *& al.* 1866 (nom. nud.) (4), unp. Mešić & Tkalčec, Saccardo 1887 HR? (2)
Exs.: CNF
(Lit.: Cappelli 1984, Hansen & Knudsen 1992)

***Agaricus bernardiiformis*** Bohus
Ref.: Focht 1986

***Agaricus bisporus*** (J.E. Lange) Imbach
= *Psalliota hortensis* (Cooke) J.E. Lange var. *bispora* J.E. Lange (1)
= *Agaricus hortensis* (Cooke) Pilát (comb. illeg.) non *A. hortensis* Pers. : Fr. (2)
= *Psalliota hortensis* (Cooke) J.E. Lange (3)
Ref.: Božac 1982 (1), Božac 1984, Tortić 1968 b, unp. Matočec (2), unp. Tortić ( )(3)
Exs.: CNF

•***Agaricus bitorquis*** (Quél.) Sacc.
= *Psalliota bitorquis* Quél. (1)
= *Agaricus bitorquis* (Quél.) Sacc. var. *validus* (F.H. Møller) Bon et Cappelli (2)
Ref.: Božac 1982 (1), Božac 1984, Božac 1986, Božac 1989, Božac 1993, Focht 1972, Focht 1974, Focht 1979, Focht 1986 (2), Majstorović 1991, Tortić 1968 b, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Bohus 1990, Cappelli 1984)

***Agaricus bresadolanus*** Bohus
= *Agaricus radicatus* (Vittad.) Romagn. (comb. illeg.) non *A. radicatus* Relhan : Fr. (1)
= *Agaricus romagnesii* Wasser
Ref.: Focht 1974 (1), Focht 1979 (1), Focht 1986 HR?

•***Agaricus campester*** L. : Fr.
= *Psalliota campestris* (L. : Fr.) Quél. (1)

Ref.: Blagaić 1921 (1), Blagaić 1931 (1), Božac 1989, Božac 1993, Focht 1972, Focht 1974, Focht 1979, Gjurašin 1898 (1), Jaap 1916 (1), Lorinser - Janda 1877 (1), Mužic & Božac 1997, Schulzer 1882 b, Schulzer *& al.* 1866, Škorić 1928 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Vouk & Pevalek 1916 (1), unp. Mešić & Tkalčec, unp. Tortić ( )(1), Schulzer 1857 HR?
Exs.: CNF
(Lit.: Bohus 1990, Cappelli 1984, Hansen & Knudsen 1992)

•***Agaricus dulcidulus*** Schulzer
Misappl.: *Agaricus semotus* Fr. sensu auct. non Fr. (1)
Ref.: Focht 1974 (1), Tortić 1968 b (1), Tortić 1973 (1), unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Bohus 1990, Cappelli 1984)

*•***Agaricus impudicus*** (Rea) Pilát
= *Agaricus koelerionensis* (Bon) Bon
= *Agaricus variegans* F.H. Møller (1)
Ref.: unp. Mešić & Tkalčec, Focht 1986 HR? (1)
Exs.: CNF
(Lit.: Bohus 1990, Cappelli 1984)

***Agaricus iodosmus*** Heinem.
Ref.: Focht 1986

***Agaricus macrocarpus*** (F.H. Møller) F.H. Møller
Ref.: Focht 1974

***Agaricus moelleri*** Wasser
= *Agaricus meleagris* (Jul. Schäff.) Imbach (comb. illeg.) non *A. meleagris* Sowerby
= *Agaricus praeclaresquamosus* A.E. Freeman
Misappl.: *Agaricus placomyces* Peck sensu auct. europ. non Peck (1)
Ref.: Barčić 1982 (1), Barčić 1996 (1)

***Agaricus porphyrizon*** P.D. Orton
Ref.: Focht 1986

•***Agaricus subperonatus*** (J.E. Lange) Singer
= *Agaricus pseudovillaticus* Rauschert
= *Agaricus vaporarius* (Pers.) Moser ex Cappelli (nom. illeg.) non *A. vaporarius* Schrank
= *Agaricus campester* L. : Fr. var. *vaporarius* Pers. (1)
Ref.: Focht 1974, Schulzer *& al.* 1866 (1), unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Cappelli 1984, Hansen & Knudsen 1992, Noordeloos *& al.* 2001)

•***Agaricus sylvaticus*** Schaeff. : Fr.
= *Psalliota sylvatica* (Schaeff. : Fr.) P. Kumm. (1)

Ref.: Blagaić 1921 (1), Blagaić 1931 (1), Schulzer *& al.* 1866, Škorić 1928 (1), unp. Matočec, Schulzer 1857 HR?

•var. ***sylvaticus***
= *Agaricus haemorrhoidarius* Schulzer
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bohus 1990, Bon 1985, Cappelli 1984)

var. ***pallidus*** (F.H. Møller) F.H. Møller
Ref.: Barčić 1989

•***Agaricus sylvicola*** (Vittad.) Peck
= *Psalliota sylvicola* (Vittad.) Richon et Roze (1)
= *Agaricus arvensis* Schaeff. subsp. *sylvicola* (Vittad.) ? (2)
= *Psalliota arvensis* Schaeff. subsp. *sylvicola* (Vittad.) Jul. Schäff. (3)
= *Agaricus essettei* Bon
Misappl.: *Agaricus abruptibulbus* Peck sensu auct. europ. non Peck (4)
Misappl.: *Psalliota abruptibulba* (Peck) Kauffman sensu auct. europ. non Peck (5)
Ref.: Božac 1982 (5), Božac 1984 (4), Božac 1986 (4), Božac 1989 (4), Božac 1993 (4), Focht 1974, Focht 1986 (4), Kranjčev 1979 (1), Tortić 1964, unp. Matočec (4), unp. Tortić ( )(2)(3) , unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bohus 1990, Cappelli 1984, Nordeloos *& al.* 2001)

•***Agaricus urinascens*** (F.H. Møller et Jul. Schäff.) Singer
= *Agaricus albertii* Bon
= *Agaricus macrosporus* (F.H. Møller et Jul. Schäff.) Pilát (comb. illeg.) non *A. macrosporus* Mont. (1)
= *Psalliota macrospora* (F.H. Møller et Jul. Schäff.) F.H. Møller (2)
Ref.: Božac 1982 (2), Božac 1984 (1), Božac 1986 (1), Božac 1989 (1), Božac 1993 (1), Kranjčev 1995 (1), Stropnik *& al.* 1988 (1), Vrščaj 1990 (1), unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bohus 1990, Cappelli 1984)

•***Agaricus xanthodermus*** Genev.
= *Psalliota xanthoderma* (Genev.) Richon et Roze (1)
= *Agaricus xanthodermus* Genev. var. *lepiotoides* Maire
= *Agaricus meleagris* (Jul. Schäff.) Imbach var. *lepiotoides* (Maire) ? (2)
= *Agaricus pseudocretaceus* Bon
Ref.: Focht 1979 ( )(2), Kranjčev 1983 (1), unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Bohus 1990, Cappelli 1984)

MOST PROBABLY FOUND IN THE TERRITORY OF CROATIA

***Agaricus bernardii*** (Quél.) Sacc.
Ref.: Focht 1986 HR?

## *Chamaemyces* Battarra ex Earle

(Lit.: Arnolds *& al.* 1995, Bon 1993, Candusso & Lanzoni 1990, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Noordeloos *& al.* 2001, Singer 1986)

•***Chamaemyces fracidus*** (Fr.) Donk
= *Chamaemyces demisannulus* (Fr.) Moser
Ref.: Božac 1984, unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Candusso & Lanzoni 1990, Hansen & Knudsen 1992, Moser 1983)

## *Cystoderma* Fayod

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Wasser 1993, Watling & Turnbull 1998)

•***Cystoderma amianthinum*** (Scop.) Fayod
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

•***Cystoderma carcharias*** (Pers.) Fayod
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Wasser 1993)

***Cystoderma granulosum*** (Batsch : Fr.) Fayod
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Tortić
Exs.: CNF

•***Cystoderma terrei*** (Berk. et Broome) Harmaja
= *Cystoderma cinnabarinum* (Alb. et Schwein.) Fayod (1)
Ref.: Focht 1974 (1), unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Wasser 1993)

## *Cystolepiota* Singer

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Bon 1981, Bon 1993, Candusso & Lanzoni 1990, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Noordeloos *& al.* 2001, Singer 1986)

•***Cystolepiota bucknallii*** (Berk. et Broome) Singer et Clémençon
= *Lepiota bucknallii* (Berk. et Broome) Sacc. (1)
Ref.: Tortić & Jelić 1970 (1), unp. Matočec (1), unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Bon 1993, Moser 1983)

***Cystolepiota seminuda*** (Lasch) Bon
= *Lepiota seminuda* (Lasch) P. Kumm. (1)
Misappl.: *Cystolepiota sistrata* (Fr. : Fr.) Singer ex Bon et Bellù sensu auct. non Fr. (2)
Ref.: Focht 1974 (1), unp. Tortić (2)

### *Lepiota* (Pers.) Gray
### = *Echinoderma* (Locq. ex Bon) Bon

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Bon 1981, Bon 1993, Candusso & Lanzoni 1990, Enderle & Krieglsteiner 1989, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Noordeloos *& al.* 2001, Singer 1986)

•***Lepiota aspera*** (Pers. : Fr.) Quél.
= *Echinoderma asperum* (Pers. : Fr.) Bon
= *Echinoderma acutesquamosum* (Weinm.) Bon
= *Lepiota acutesquamosa* (Weinm.) P. Kumm. (1)
= *Echinoderma friesii* (Lasch : Fr.) Bon
Ref.: Barčić 1982, Barčić 1996 ( )(1), Blagaić 1921 (1), Blagaić 1931 (1), Focht 1979 (1), Lisiewska & Tortić 1990, Tortić 1964 (1), Tortić 1966 a (1), Tortić 1966 b (1), Vouk & Pevalek 1916 (1), unp. Lisiewska, unp. Matočec (1), unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF, POZM
(Lit.: Bon 1993, Candusso & Lanzoni 1990, Hansen & Knudsen 1992)

***Lepiota boudieri*** Bres.
= *Lepiota fulvella* Rea (1)
Ref.: Tortić 1973 (1), unp. Tortić (1)

***Lepiota brunneoincarnata*** Chodat et C. Martin
Ref.: Focht 1979, Focht 1983 b

***Lepiota clypeolaria*** (Bull. : Fr.) P. Kumm.
= *Agaricus clypeolarius* Bull. : Fr. (1)
Ref.: Gjurašin 1898, Lisiewska & Tortić 1990, Schulzer *& al.* 1866 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić
Exs.: POZM

***Lepiota cristata*** (Bolton : Fr.) P. Kumm.
= *Lepiota subfelinoides* Bon et P.D. Orton

Ref.: Focht 1974, Focht 1979, Tortić 1964, Tortić 1966 a, Tortić 1966 b, unp. Matočec, unp. Tortić, Focht 1986 HR?
Exs.: CNF

***Lepiota erminea*** (Fr. : Fr.) P. Kumm.
= *Agaricus ermineus* Fr. : Fr. (1)
- as *Agaricus "eminens"* Fr. (2)
= *Lepiota alba* (Bres.) Sacc. (3)
Ref.: Božac 1984 (3), Schulzer *& al.* 1866 (2) + Schulzer 1867 (1) , unp. Tortić (3)

***Lepiota felina*** (Pers.) P. Karst.
Ref.: Kišpatić 1950

***Lepiota helveola*** Bres.
Ref.: Barčić 1982, Barčić 1996, Focht 1983 b

***Lepiota magnispora*** Murrill
= *Lepiota ventriosospora* D.A. Reid (1)
Misappl.: *Lepiota metulispora* (Berk. et Broome) Sacc. sensu Bres. non Berk. et Broome (2)
Ref.: Tortić 1968 b (2), unp. Matočec (1), unp. Tortić (1)(2)

## *Leucoagaricus* (Locq.) ex Singer

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Bon 1981, Bon 1993, Candusso & Lanzoni 1990, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Noordeloos *& al.* 2001, Reid 1990, Singer 1986, Wasser 1993)

•***Leucoagaricus americanus*** (Peck) Vellinga
= *Lepiota americana* (Peck) Sacc.
= *Lepiota bresadolae* Schulzer (1)
= *Leucoagaricus bresadolae* (Schulzer) Bon
= *Leucocoprinus bresadolae* (Schulzer) Wasser (2)
= *Agaricus cupreus* Schulzer (nom. illeg.) (3)
Ref.: Schulzer 1878 (3), Schulzer 1885 (1), Tortić 1993 (2), unp. Kotlaba (according to unp. Tortić) (1), unp. Mešić & Tkalčec, Saccardo 1887 HR? (1)
Exs.: CNF, PRM (1)
(Lit.: Bon 1993, Reid 1990)

***Leucoagaricus badhamii*** (Berk. et Broome) Singer
= *Leucocoprinus badhamii* (Berk. et Broome) Locq. (1)
Ref.: Božac 1984 (1), Božac 1986 (1), Božac 1989 (1), Božac 1993 (1), Focht 1986 (1)

***Leucoagaricus holosericeus*** (Fr.) Moser
Ref.: Kranjčev 1995

•***Leucoagaricus leucothites*** (Vittad.) Wasser
= *Lepiota naucina* (Fr.) P. Kumm. (1)
= *Leucoagaricus naucinus* (Fr.) Singer
Misappl.: *Lepiota pudica* (Bull.) Quél. sensu auct. non Bull. (2)
(sensu Bull. = nom. conf. - Noordeloos *& al.* 2001)
Misappl.: *Leucoagaricus pudicus* (Bull.) Bon sensu auct. non Bull. (3)
Ref.: Barčić 1982 (3), Barčić 1996 (3), Blagaić 1923 (2), Blagaić 1931 (1), Focht 1983 b (3), Tortić 1964 (3), unp. Matočec (3), unp. Mešić & Tkalčec, unp. Tortić (1)(2)
Exs.: CNF
(Lit.: Bon 1993)

***Leucoagaricus littoralis*** (Menier) Bon et Boiffard
Ref.: Focht 1986

## *Macrolepiota* Singer

(Lit.: Arnolds *& al.* 1995, Bellù & Lanzoni 1987, Bon 1981, Bon 1993, Candusso & Lanzoni 1990, Hansen & Knudsen 1992, de Kok & Vellinga 1998, Kreisel 1987, Moser 1983, Noordeloos *& al.* 2001, Pázmány 1985, Singer 1986, Wasser 1993)

***Macrolepiota excoriata*** (Schaeff. : Fr.) Wasser
= *Agaricus excoriatus* Schaeff. : Fr. (1)
= *Lepiota excoriata* (Schaeff. : Fr.) P. Kumm. (2)
Ref.: Božac 1984, Focht 1979 (2), Gjurašin 1898 (2), Schulzer *& al.* 1866 (1), Tortić & Lisiewska 1978, unp. Lisiewska, unp. Matočec (2), unp. Tortić, Schuzer 1857 HR? (1)
Exs.: POZM

•***Macrolepiota mastoidea*** (Fr. : Fr.) Singer
= *Macrolepiota konradii* (Huijsman ex P.D. Orton) Moser (1)
= *Macrolepiota rickenii* (Velen.) Bellù et Lanzoni
Misappl.: *Lepiota gracilenta* (Krombh.) Quél. sensu auct. non Krombh. (2)
(sensu Krombh. = ? *Chlorophyllum molybdites* (G. Mey. : Fr.) Massee - Bellù & Lanzoni 1987)
Misappl.: *Macrolepiota gracilenta* (Krombh.) Wasser sensu auct. non Krombh. (3)
Ref.: Focht 1979 (2), Focht 1986 (1), Tortić 1964, Tortić 1964 ? (3), Tortić 1973, unp. Matočec, unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Noordeloos *& al.* 2001)

*****Macrolepiota nympharum*** (Kalchbr.) Wasser
= *Leucoagaricus nympharum* (Kalchbr.) Bon
= *Lepiota puellaris* (Fr.) Rea (1)

= *Macrolepiota puellaris* (Fr.) Moser
Ref.: unp. Matočec (1)

***Macrolepiota permixta*** (Barla) Pacioni
= *Lepiota permixta* Barla (1)
= *Macrolepiota procera* (Scop. : Fr.) Singer var. *permixta* (Barla) Candusso
Ref.: Focht 1974 (1)

•***Macrolepiota procera*** (Scop. : Fr.) Singer
= *Agaricus procerus* Scop. : Fr. (1)
= *Lepiota procera* (Scop. : Fr.) Gray (2)
Ref.: Barčić 1989, Barčić 1996, Blagaić 1921 (2), Blagaić 1931 (2), Focht 1972, Focht 1974 (2), Focht 1979 (2), Focht 1983 b, Focht 1986, Gjurašin 1898 (2), Kranjčev 1979, Kranjčev 1986, Kranjčev 1995 (2), Lorinser - Janda 1877 (2), Mužic & Božac 1997, Schulzer *& al.* 1866 (1), Škorić 1928 (2), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1994, Tortić & Lisiewska 1978, Urbani 1946 (2), Vouk & Pevalek 1915 (2), unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić ( )(2), Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Bon 1993, Candusso & Lanzoni 1990)

•***Macrolepiota rachodes*** (Vittad.) Singer
= *Lepiota rachodes* (Vittad.) Quél. (1)
= *Macrolepiota rachodes* (Vittad.) Singer var. *bohemica* (Wichansky) Bellù et Lanzoni
= *Macrolepiota olivieri* (Barla) Wasser
Misappl.: *Macrolepiota rachodes* (Vittad.) Singer var. *hortensis* (Pilát) Wasser (nom. inval.) sensu auct. non Pilát (2)
Ref.: Božac 1989 (2), Božac 1993 (2), Kišpatić 1950 (1), Kranjčev 1995, Tortić 1964, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Bon 1993, Candusso & Lanzoni 1990)

### **Melanophyllum* Velen.

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1960, Bon 1981, Bon 1993, Candusso & Lanzoni 1990, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Noordeloos *& al.* 2001, Singer 1986)

*•***Melanophyllum haematospermum*** (Bull. : Fr.) Kreisel
= *Melanophyllum echinatum* (Roth : Fr.) Singer
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Candusso & Lanzoni 1990, Moser 1983)

## ***Phaeolepiota*** Maire ex Konrad et Maubl.

(Lit.: Arnolds *& al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Wasser 1993)

•***Phaeolepiota aurea*** (Matt. : Fr.) Maire ex Konrad et Maubl.
= *Agaricus aureus* Matt. : Fr. (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867 (1), unp. Lindtner, unp. Matočec, unp. Mešić & Tkalčec
Exs.: BEO, CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Wasser 1993)

## Familia **Amanitaceae** R. Heim ex Pouzar

## ***Amanita*** Pers.

(Lit.: Arnolds *& al.* 1995, Bas 1969, Dennis *& al.* 1960, Fraiture 1993, Fries 1821, Fries 1874, Gilbert 1940-1941, Hansen & Knudsen 1992, Kreisel 1987, Merlo & Traverso 1983, Moser 1983, Neville & Poumarat 1996, Parrot 1960, Singer 1986)

***Amanita battarrae*** (Boud.) Bon
= *Amanita umbrinolutea* (Secr. ex Gillet) Bataille (1)
Ref.: Barčić 1989 (1), Barčić 1996 (1), Focht 1974 (1), Tortić 1973 (1), unp. Matočec (1), unp. Tortić (1), Tortić 1993 ? (1)
Exs.: CNF

***Amanita beckeri*** Huijsman
Ref.: Božac 1984, Focht 1986, unp. Matočec

•***Amanita caesarea*** (Scop. : Fr.) Pers.
= *Agaricus caesareus* Scop. : Fr. (1)
Ref.: Focht 1974, Focht 1979, Focht 1981 b, Focht 1986, Kranjčev 1995, Lange 1974, Lorinser - Janda 1877, Schulzer *& al.* 1866 (1), Tortić 1964, Tortić 1970, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Mešić & Tkalčec, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Merlo & Traverso 1983, Moser 1983)

•***Amanita ceciliae*** (Berk. et Broome) Bas
= *Amanita inaurata* Secr. ex Gillet (1)
Misappl.: *Amanita strangulata* (Fr.) Quél. sensu auct. non Fr. 1836-1838 (2)
Misappl.: *Amanitopsis strangulata* (Fr.) Roze sensu auct. non Fr. 1836-1838 (3)
Ref.: Blagaić 1921 (3), Božac 1982 (2), Božac 1984 (1), Božac 1986 (1), Božac 1989 (1), Božac 1993 (1), Fraiture 1993 (2), Tortić 1968 b (1), Tortić & Lisiewska 1978 (1), unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Fraiture 1993)

•***Amanita citrina*** (Schaeff. →) Pers.
= *Amanita mappa* (Batsch) Quél. var. *citrina* (Schaeff. → Pers.) ? (1)
= *Amanita mappa* (Batsch) Quél. (2)
Ref.: Barčić 1982, Barčić 1996, Blagaić 1921 (1), Gjurašin 1898, Kranjčev 1979, Lange 1974, Lisiewska & Tortić 1990 (2), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tortić
Exs.: BEO, CNF

•var. ***citrina***
= *Agaricus phalloides* Vaill. ex Fr. : Fr. var. *citrinus* (Schaeff. → Pers.) ? (3)
= *Agaricus phalloides* Vaill. ex Fr. : Fr. var. "b. - pil. flavo" Fr. 1821 (4)
Ref.: Schulzer *& al.* 1866 (3), unp. Mešić & Tkalčec, Schulzer 1857 HR? (4)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983, Moser 1983)

var. ***alba*** (Gillet) J.-E. Gilbert
= *Agaricus phalloides* Vaill. ex Fr. : Fr. var. *bulbosus* (Schaeff.) ? (5)
Ref.: Božac 1984, Schulzer *& al.* 1866 (5)

•***Amanita crocea*** (Quél.) Singer
= *Amanita vaginata* (Bull. : Fr.) Lam. var. *crocea* Quél. (1)
Ref.: Focht 1979 (1), Fraiture 1993, Tortić & Lisiewska 1978, unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Fraiture 1993)

•***Amanita eliae*** Quél.
= *Amanita gemmata* (Fr.) Bertillon var. *eliae* (Quél.) ? (1)
Ref.: Božac 1984, Focht 1979, Focht 1986, Tortić 1964, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983, Moser 1983)

•***Amanita excelsa*** (Fr. : Fr.) Bertillon
= *Amanita spissa* (Fr.) Opiz (1)
Ref.: Barčić 1989 (1), Barčić 1996 (1), Focht 1983 b (1), Škorić 1928, Tortić 1964 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić & Lisiewska 1978 (1), Vouk & Pevalek 1916 (1), unp. Matočec (1), unp. Mešić & Tkalčec, unp. Tortić (1), Focht 1986 HR?
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983, Moser 1983)

***Amanita flavescens*** (J.-E. Gilbert et S. Lundell) Contu
= *Amanita vaginata* (Bull. : Fr.) Lam. var. *flavescens* J.-E. Gilbert et S. Lundell (1)
Ref.: Božac 1984 (1)

•***Amanita franchetii*** (Boud.) Fayod
Misappl.: *Amanita aspera* (Fr. : Fr.) Gray sensu auct. non Fr. (1)
Ref.: Božac 1984 (1), Stropnik *& al.* 1988 (1), Tortić 1968 b (1), unp. Mešić & Tkalčec, unp. Tortić (1), Focht 1986 HR? (1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983, Moser 1983)

***Amanita friabilis*** (P. Karst.) Bas
Ref.: Focht 1986

•***Amanita fulva*** (Schaeff.) Fr.
= *Agaricus vaginatus* Bull. : Fr. var. *fulvus* (Schaeff.) Loudon (1)
= *Amanita vaginata* (Bull. : Fr.) Lam. var. *fulva* (Schaeff.) Gillet (2)
Ref.: Focht 1972 (2), Focht 1974 (2), Focht 1986, Fraiture 1993, Tortić & Lisiewska 1978, unp. Mešić & Tkalčec, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Fraiture 1993)

•***Amanita gemmata*** (Fr.) Bertillon
= *Amanita junquillea* Quél. (1)
Ref.: Barčić 1982, Barčić 1996, Focht 1979, Gjurašin 1898 (1), Tortić 1964, Tortić & Lisiewska 1978, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983, Moser 1983)

***Amanita gilbertii*** Beauseign.
Ref.: Focht 1986

•***Amanita lepiotoides*** Barla
Ref.: Božac 1984, Focht 1986, unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Merlo & Traverso 1983)

***Amanita lividopallescens*** (Gillet) Seyot
= *Amanita vaginata* (Bull. : Fr.) Lam. var. *lividopallescens* Gillet (1)
Ref.: Barčić 1982, Barčić 1996, Focht 1974, Focht 1979 (1), Focht 1986 HR?

***Amanita lividopallescens*** (Gillet) Seyot **sensu lato**
Ref.: Fraiture 1993
Annotation: Fraiture (1993) uses term "complex" instead of term "sensu lato".

*•***Amanita mairei*** Foley

= *Amanita argentea* Huijsman
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Fraiture 1993, Moser 1983)

•***Amanita muscaria*** (L. : Fr.) Lam.

= *Agaricus muscarius* L. : Fr. (1)
Ref.: Focht 1979, Focht 1986, Gjurašin 1898, Kranjčev 1979, Kranjčev 1986, Lorinser - Janda 1877, Schulzer *& al.* 1866 (1), Škorić 1928, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1994, Tortić & Lisiewska 1978, Vouk & Pevalek 1915, Vouk & Pevalek 1916, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983, Moser 1983)

•***Amanita ovoidea*** (Bull. : Fr.) Link

Ref.: Blagaić 1921, Božac 1982, Božac 1984, Božac 1986, Božac 1989, Božac 1993, Focht 1974, Focht 1979, Focht 1986, unp. Mešić & Tkalčec, unp. Tortić, Focht 1983 b HR?
Exs.: CNF
(Lit.: Merlo & Traverso 1983)

•***Amanita pantherina*** (DC. : Fr.) Krombh.

= *Agaricus pantherinus* DC. : Fr. (1)
= *Amanita umbrina* Pers. (2)
Ref.: Barčić 1982, Barčić 1984, Barčić 1996, Focht 1974, Focht 1983 b, Forenbacher 1915 (2), Gjurašin 1898, Kranjčev 1979, Lorinser - Janda 1877, Schulzer *& al.* 1866 (1), Škorić 1928 (2), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (2), unp. Matočec, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF

•var. ***pantherina***

Ref.: Focht 1986 (as *A. pantherina*), unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Merlo & Traverso 1983, Moser 1983)

var. ***abietum*** (J.-E. Gilbert) Veselý

Ref.: Focht 1986

•***Amanita phalloides*** (Vaill. ex Fr. : Fr.) Link

Ref.: Focht 1974, Focht 1979, Gjurašin 1898, Kranjčev 1979, Lange 1974, Lisiewska & Tortić 1990, Lorinser - Janda 1877, Mužic & Božac 1997, Tortić 1958, Tortić 1964, Tortić & Lisiewska 1978, unp. Lindtner, unp. Matočec, unp. Tortić
Exs.: BEO, CNF

•var. ***phalloides***

= *Agaricus phalloides* Vaill. ex Fr. : Fr. var. "d. - pil. olivaceo-viridi" Fr. 1821 (1)

Ref.: Focht 1986, unp. Mešić & Tkalčec, Schulzer 1857 HR? (1)

Exs.: CNF

(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983, Moser 1983)

var. ***alba*** J.-E. Gilbert

- as *Amanita phalloides* (Vaill. ex Fr. : Fr.) Link var. *verna* Bull. (2)

Ref.: Božac 1984, Focht 1983 b (2), Focht 1986

•***Amanita porphyria*** (Alb. et Schwein. : Fr.) Mladý

Ref.: Tortić 1993, unp. Mešić & Tkalčec, unp. Tortić

Exs.: CNF

(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983, Moser 1983)

***Amanita regalis*** (Fr.) Michael

= *Amanita muscaria* (L. : Fr.) Lam. var. *regalis* (Fr.) Sacc. (1)

Ref.: Focht 1979 (1), Focht 1983 b, Focht 1986

•***Amanita rubescens*** Pers. : Fr.

= *Agaricus rubescens* (Pers. : Fr.) Fr. (1)

= *Amanita pseudorubescens* Herrfurth (2)

= *Amanita pustulata* (Schaeff.) J. Schröt. (3)

Ref.: Barčić 1989, Barčić 1996, Blagaić 1931, Focht 1979 (2), Focht 1986, Kranjčev 1979, Kranjčev 1986, Lisiewska & Tortić 1990, Lorinser - Janda 1877, Schulzer *& al.* 1866 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (3), unp. Matočec, unp. Tortić, Focht 1979 HR?, Schulzer 1857 HR? (1)

Exs.: CNF

•var. ***rubescens***

Ref.: unp. Mešić & Tkalčec

Exs.: CNF

(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983)

*•var. ***annulosulphurea*** Gillet

Ref.: unp. Mešić & Tkalčec

Exs.: CNF

(Lit.: Hansen & Knudsen 1992, Merlo & Traverso 1983)

•***Amanita solitaria*** (Bull. : Fr.) Mérat

= *Amanita echinocephala* (Vittad.) Quél. (1)

Ref.: Bas 1969, Božac 1982 (1), Božac 1984 (1), Tortić 1965 (1), unp. Mešić & Tkalčec, unp. Tortić (1), Focht 1986 HR? (1)

Exs.: CNF, L

(Lit.: Bas 1969)

•***Amanita strobiliformis*** (Paulet ex Vittad.) Bertillon
Misappl.: *Amanita solitaria* (Bull. : Fr.) Mérat sensu auct. non Bull. (1)
Ref.: Božac 1982 (1), Božac 1984, Božac 1986, Božac 1989, Božac 1993, Focht 1974 (1), Focht 1986, Lange 1974, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1993, unp. Mešić & Tkalčec, unp. Tortić ( )(1), Focht 1979 HR? (1), Focht 1983 b HR?
Exs.: CNF
(Lit.: Bas 1969)

•***Amanita vaginata*** (Bull. : Fr.) Lam.
= *Agaricus vaginatus* Bull. : Fr. (1)
= *Amanitopsis vaginata* (Bull. : Fr.) Roze (2)
Ref.: Barčić 1982, Barčić 1996, Blagaić 1921 (2), Focht 1974, Fraiture 1993, Gjurašin 1898, Lisiewska & Tortić 1990, Schulzer 1882 a (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, unp. Matočec, unp. Tortić

•var. ***vaginata***
= *Agaricus vaginatus* Bull. : Fr. var. "b. - pil. griseo, livido" Fr. 1821 (3)
= *Amanita vaginata* (Bull. : Fr.) Lam. var. *grisea* (DC.) Quél. et Bataille (4)
= *Amanitopsis plumbea* (Schaeff.) Fayod (5)
= *Amanita vaginata* (Bull. : Fr.) Lam. var. *plumbea* (Schaeff.) Quél. et Bataille (6)
Ref.: Focht 1972 (4), Focht 1974 (4)(6), Schulzer *& al.* 1866 (3), Vouk & Pevalek 1916 (5), unp. Mešić & Tkalčec, Schulzer 1857 HR? (3)
Exs.: CNF
(Lit.: Fraiture 1993)

var. ***alba*** (De Seynes) Gillet
= *Amanitopsis plumbea* (Schaeff.) Fayod var. *alba* (De Seynes) J. Schröt. (7)
Ref.: Focht 1974, Škorić 1928 (7), Vouk & Pevalek 1916 (7)

var. ***badia*** (Schaeff.) Quél. et Bataille
= *Amanitopsis plumbea* (Schaeff.) Fayod var. *badia* (Schaeff.) J. Schröt. (8)
Ref.: Škorić 1928 (8), Vouk & Pevalek 1916 (8)

***Amanita vaginata*** (Bull. : Fr.) Lam. **sensu lato**
Ref.: Tortić 1993

***Amanita verna*** (Bull. : Fr.) Lam.
= *Amanita verna* (Bull. : Fr.) Lam. var. *verna* (1)
Ref.: Focht 1983 b, Focht 1986 HR? (1)

***Amanita virosa*** (Fr.) Bertillon
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, unp. Tortić
Exs.: CNF

***Amanita vittadinii*** (Moretti) Vittad.
Ref.: Focht 1974, Focht 1986, Focht 1979 HR?

### MOST PROBABLY FOUND IN THE TERRITORY OF CROATIA

***Amanita boudieri*** Barla
Ref.: Focht 1986 HR?

***Amanita codinae*** (Maire) Singer
Ref.: Focht 1986 HR?

***Amanita curtipes*** J.-E. Gilbert
Ref.: Focht 1986 HR?

***Amanita lactea*** Malençon, Romagn. et D.A. Reid
Ref.: Focht 1983 b HR?, Focht 1986 HR?

## *Limacella* Earle

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986)

***Limacella guttata*** (Pers. : Fr.) Konrad et Maubl.
= *Amanita lenticularis* (Lasch : Fr.) J.E. Lange (1)
= *Limacella lenticularis* (Lasch : Fr.) Maire (2)
Ref.: Focht 1974 (2), Vouk & Pevalek 1916 (1)

***Limacella illinita*** (Fr. : Fr.) Murrill
= *Lepiota illinita* (Fr. : Fr.) Quél. (1)
Ref.: Božac 1984, Vouk & Pevalek 1915 (1), unp. Matočec, unp. Tortić
Exs.: CNF

# Familia **Cortinariaceae** R. Heim ex Pouzar

## *Alnicola* Kühner

Misappl.: *Naucoria* (Fr.) P. Kumm. sensu auct. non Fr.
(sensu Fr. = nom. conf. - Arnolds *& al.* 1995)

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Bon 1992, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986)

*__*Alnicola melinoides__* (Bull. : Fr.) Kühner
Misappl.: *Alnicola escharoides* (Fr. : Fr.) Romagn. sensu auct. non Fr. (1)
(sensu Fr. = nom. dub. - Singer 1986)
Misappl.: *Naucoria escharoides* (Fr. : Fr.) P. Kumm. sensu auct. non Fr.
Ref.: unp. Tortić (1)
Exs.: CNF

***Alnicola scolecina*** (Fr.) Romagn.
= *Naucoria scolecina* (Fr.) Quél.
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

## ***Cortinarius*** (Pers.) Roussel
= *Dermocybe* (Fr.) Wünsche

(Lit.: Arnold 1993, Arnolds *& al.* 1995, Bollmann *& al.* 1996, Dennis *& al.* 1960, Fries 1836-1838, Fries 1874, Hansen & Knudsen 1992, Høiland 1984, Kreisel 1987, Moser 1960, Moser 1983, Nespiak 1975, Nespiak 1981, Nezdojminogo 1983, Singer 1986)

***Cortinarius affinis*** Allesch.
Ref.: Vouk & Pevalek 1915

***Cortinarius alboviolaceus*** (Pers. : Fr.) Fr.
Ref.: Lisiewska & Tortić 1990, unp. Tortić

*•***Cortinarius armillatus*** (Fr. : Fr.) Fr.
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Moser 1983)

****Cortinarius atrovirens*** Kalchbr.
= *Phlegmacium atrovirens* (Kalchbr.) Ricken (1)
Ref.: unp. Tortić (1)
Exs.: CNF

***Cortinarius azureus*** Fr.
= *Phlegmacium azureum* (Fr.) Moser (1)
Ref.: Tortić 1968 b (1), Tortić & Lisiewska 1978, unp. Tortić (1)
Exs.: CNF

***Cortinarius bivelus*** (Fr. : Fr.) Fr.
Ref.: Tortić & Lisiewska 1978, Vouk & Pevalek 1915, unp. Lisiewska, unp. Tortić
Exs.: POZM

•***Cortinarius bolaris*** (Pers. : Fr.) Fr.
Ref.: Focht 1983 b, Focht 1986, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

***Cortinarius bovinus*** Fr.
Ref.: Tortić & Lisiewska 1978, unp. Lisiewska
Exs.: POZM

***Cortinarius brunneofulvus*** Fr.
Ref.: Vouk & Pevalek 1915

***Cortinarius bulliardii*** (Pers. : Fr.) Fr.
= *Hydrocybe bulliardii* (Pers. : Fr.) ? (1)
Ref.: Schulzer *& al.* 1866, Tortić 1964 (1), Tortić & Lisiewska 1978, unp. Tortić
Exs.: CNF

***Cortinarius caesiocyaneus*** Britzelm.
= *Phlegmacium caesiocyaneum* (Britzelm.) Moser (1)
Ref.: Tortić 1968 b (1), Tortić & Lisiewska 1978, unp. Tortić ( )(1)
Exs.: CNF

***Cortinarius castaneus*** (Bull. : Fr.) Fr.
Ref.: Schulzer *& al.* 1866

•***Cortinarius cinnabarinus*** Fr.
= *Dermocybe cinnabarina* (Fr.) Wünsche (1)
Ref.: Kranjčev 1995 (1), Tortić 1968 b (1), unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Høiland 1984)

***Cortinarius cinnamomeoluteus*** P.D. Orton
= *Dermocybe cinnamomeolutea* (P.D. Orton) Moser (1)
Ref.: Tortić & Lisiewska 1978 (1)

***Cortinarius cinnamomeus*** (L. : Fr.) Fr. **sensu lato**
Incl.: *Cortinarius cinnamomeus* (L. : Fr.) Fr.
= *Dermocybe cinnamomea* (L. : Fr.) Wünsche (1)
*Cortinarius croceus* (Schaeff.) Bigeard et H. Guill.
Misappl.: *Cortinarius cinnamomeus* (L. : Fr.) Fr. sensu Bres., J.E. Lange non L.
Misappl.: *Dermocybe cinnamomea* (L. : Fr.) Wünsche sensu Ricken non L.
Ref.: Picbauer 1928 (1), Pilát 1925 (1)
Annotation: The authors of the records for Croatia could easily have misapplied name *Dermocybe cinnamomea* to species *Cortinarius croceus*.

*****Cortinarius coerulescens*** (Schaeff.) Fr.
Ref.: unp. Tortić

***Cortinarius collinitus*** (Sowerby : Fr.) Gray
= *Agaricus collinitus* Sowerby : Fr. (1)
Ref.: Božac 1984, Gjurašin 1898, Schulzer *& al.* 1866, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, Schulzer 1857 HR? (1)

*****Cortinarius cotoneus*** Fr.
Ref.: unp. Tortić

***Cortinarius croceus*** (Schaeff.) Bigeard et H. Guill.
= *Dermocybe crocea* (Schaeff.) Moser
= *Cortinarius cinnamomeobadius* Rob. Henry
= *Dermocybe cinnamomeobadia* (Rob. Henry) Moser (1)
= *Cortinarius cinnamomeolutescens* Rob. Henry (nom. inval.) (2)
= *Dermocybe cinnamomeolutescens* (Rob. Henry) Moser (nom. inval.) (3)
Ref.: Focht 1972 (1), Tortić 1966 a (3), Tortić 1966 b (3), Tortić 1968 b (3), unp. Tortić (2)(3)
Exs.: CNF

***Cortinarius decoloratus*** (Fr. : Fr.) Fr.
Ref.: Vouk & Pevalek 1916

***Cortinarius delibutus*** Fr.
= *Myxacium delibutum* (Fr.) Ricken (1)
Ref.: Tortić 1973, unp. Tortić (1)
Exs.: CNF

***Cortinarius dibaphus*** Fr.
= *Phlegmacium dibaphum* (Fr.) Ricken (1)
Ref.: Tortić 1966 a (1), Tortić 1966 b (1), unp. Tortić
Exs.: CNF

***Cortinarius dilutus*** (Pers.) Fr.
= *Cortinarius saturatus* J.E. Lange
Ref.: Vouk & Pevalek 1915, Vouk & Pevalek 1916

***Cortinarius elegantior*** (Fr.) Fr.
Ref.: Tortić 1973
Exs.: CNF ?

***Cortinarius erythrinus*** (Fr.) Fr.
= *Hydrocybe erythrina* (Fr.) Ricken (1)
Ref.: Tortić 1968 b (1), unp. Tortić (1)
Exs.: CNF

***Cortinarius firmus*** (Weinm.) Fr.
Ref.: Škorić 1928

****Cortinarius fulmineus*** (Fr.) Fr.
Ref.: unp. Tortić

***Cortinarius glaucopus*** (Schaeff. : Fr.) Fr.
Ref.: Lisiewska & Tortić 1990, Tortić 1973
Exs.: CNF

****Cortinarius gracilior*** (Jul. Schäff. ex Moser) Moser
Ref.: unp. Tortić
Exs.: CNF

**Cortinarius hemitrichus** (Pers. : Fr.) Fr.
Ref.: Tortić 1973, unp. Tortić
Exs.: CNF

**Cortinarius hinnuleus** (Sowerby) Fr.
= *Hydrocybe hinnulea* (Sowerby) Moser (1)
Ref.: Focht 1974 (1), Tortić 1973, Tortić & Lisiewska 1978, unp. Tortić
Exs.: CNF

****Cortinarius infractus*** (Pers. : Fr.) Fr.
Ref.: unp. Tortić
Exs.: CNF

**Cortinarius ionochlorus** Maire
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

**Cortinarius largus** Fr.
Ref.: Tortić 1973
Exs.: CNF ?

**Cortinarius limonius** (Fr. : Fr.) Fr.
Ref.: Gjurašin 1898

**Cortinarius lividoochraceus** (Berk.) Berk.
= *Cortinarius elatior* Fr. (nom. illeg.) (1)
= *Myxacium elatius* (Fr. →) Wünsche (2)
Ref.: Tortić 1966 a (2), Tortić 1966 b (2), unp. Matočec (1), unp. Tortić (1)(2)
Exs.: CNF, Mrvoš (from Matočec) (1)

****Cortinarius multiformis*** (Fr.) Fr.
= *Phlegmacium multiforme* (Fr.) Wünsche (1)
Ref.: unp. Tortić
Exs.: CNF

**Cortinarius nemorensis** (Fr.) J.E. Lange
= *Phlegmacium nemorense* (Fr.) de Lanessan (1)
Ref.: Tortić 1968 b (1), unp. Tortić
Exs.: CNF

**Cortinarius obtusus** (Fr. : Fr.) Fr.
= *Cortinarius scandens* Fr.
Ref.: Vouk & Pevalek 1915

**Cortinarius odorifer** Britzelm.
= *Phlegmacium odorifer* (Britzelm.) Moser (1)
Ref.: Lisiewska 1993, Lisiewska & Tortić 1990, unp. Tortić ( )(1)
Exs.: CNF

**Cortinarius orellanus** Fr.
= *Dermocybe orellana* (Fr.) Ricken (1)

Ref.: Focht 1979 (1), unp. Tortić
Exs.: CNF

***Cortinarius percomis*** Fr.
= *Phlegmacium percome* (Fr.) A. Blytt (1)
Ref.: Focht 1986 (1), Tortić 1966 a (1), Tortić 1966 b (1), unp. Tortić
Exs.: CNF

****Cortinarius phoeniceus*** (Bull.) Maire
= *Dermocybe phoenicea* (Bull.) Moser (1)
Ref.: unp. Tortić ( )(1)
Exs.: CNF

*•***Cortinarius praestans*** (Cordier) Gillet
Ref.: unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Moser 1983)

****Cortinarius purpurascens*** (Fr.) Fr.

*var. ***largusoides*** (Rob. Henry) Moser
Ref.: unp. Tortić
Exs.: CNF

***Cortinarius rubicundulus*** (Rea) A. Pearson
= *Cortinarius pseudobolaris* Maire (1)
Ref.: Focht 1983 b (1)

****Cortinarius rufoolivaceus*** (Pers. : Fr.) Fr.
= *Phlegmacium rufoolivaceum* (Pers. : Fr.) Wünsche (1)
Ref.: unp. Tortić, Tortić 1968 b ? (1)
Exs.: CNF

***Cortinarius russeus*** Rob. Henry
Ref.: Lisiewska 1993, Lisiewska & Tortić 1990, unp. Lisiewska, unp. Tortić
Exs.: POZM

***Cortinarius semisanguineus*** (Fr.) Gillet
= *Dermocybe semisanguinea* (Fr.) Moser (1)
= *Dermocybe pallidipes* Moser (nom. inval.)
Ref.: Barčić 1989 (1), Barčić 1996 (1), Tortić 1966 a (1), Tortić 1966 b (1), unp. Tortić ( )(1)
Exs.: CNF

***Cortinarius sodagnitus*** Rob. Henry
= *Phlegmacium sodagnitum* (Rob. Henry) Moser (1)
Ref.: Barčić 1982, Barčić 1996, Focht 1974 (1)

***Cortinarius splendens*** Rob. Henry
= *Phlegmacium splendens* (Rob. Henry) Moser (1)
Ref.: Focht 1986 (1), Tortić 1968 b (1), unp. Tortić (1)
Exs.: CNF

***Cortinarius subfulgens** P.D. Orton
Ref.: unp. Lisiewska
Exs.: POZM

**Cortinarius subsertipes** Romagn.
= *Hydrocybe subsertipes* (Romagn.) ? (1)
Ref.: Focht 1974 (1)

**Cortinarius torvus** (Fr. : Fr.) Fr.
Ref.: Vouk & Pevalek 1916, unp. Matočec, unp. Tortić
Exs.: Mrvoš (from Matočec)

**Cortinarius traganus** (Fr. : Fr.) Fr.
= *Phlegmacium traganum* (Fr. : Fr.) Moser (1)
Ref.: Focht 1979 (1), Tortić 1966 a (1), Tortić 1966 b (1), Vouk & Pevalek 1915, unp. Tortić
Exs.: CNF

**Cortinarius trivialis** J.E. Lange
= *Myxacium triviale* (J.E. Lange) Moser (1)
Ref.: Tortić 1964 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić & Lisiewska 1978, unp. Matočec, unp. Tortić ( )(1)
Exs.: CNF

**Cortinarius variecolor** (Pers. : Fr.) Fr.
= *Phlegmacium variecolor* (Pers. : Fr.) Wünsche (1)
Ref.: Lisiewska 1993, Lisiewska & Tortić 1990, unp. Lisiewska, unp. Tortić (1)
Exs.: POZM

***Cortinarius varius** (Schaeff. : Fr.) Fr.
Ref.: unp. Tortić
Exs.: CNF

**Cortinarius venetus** (Fr.) Fr.
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Tortić
Exs.: CNF

**Cortinarius vibratilis** (Fr. : Fr.) Fr.
= *Myxacium vibratile* (Fr. : Fr.) P. Kumm. (1)
Ref.: Tortić 1966 a (1), Tortić 1966 b (1), unp. Tortić
Exs.: CNF

•**Cortinarius violaceus** (L. : Fr.) Gray
= *Cortinarius hercynicus* (Pers.) Moser
Ref.: Lange 1974, Tortić 1968 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: BEO, CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983)

**Cortinarius zinziberatus** (Scop.) Fr.
Ref.: Božac 1984

## *Galerina* Earle

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Bon 1992, Hansen & Knudsen 1992, Jacobsson 1991, Kreisel 1987, Kühner 1935, Moser 1983, Pilát 1951 b, Škorić 1928, Watling & Gregory 1993)

***Galerina hypnorum*** (Schrank : Fr.) Kühner
= *Derminus hypni* (Batsch) J. Schröt. (1)
Ref.: Focht 1974, Škorić 1928 (1)

•***Galerina marginata*** (Batsch) Kühner
Ref.: Tortić 1968 b, Tortić 1973, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF, Mrvoš (from Matočec), PRM
(Lit.: Bon 1992, Hansen & Knudsen 1992, Watling & Gregory 1993)

***Galerina pumila*** (Pers. : Fr.) M. Lange ex Singer
Ref.: Tortić 1973, unp. Tortić
Exs.: CNF

*•***Galerina tibiicystis*** (G.F. Atk.) Kühner
Ref.: unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Bon 1992, Moser 1983, Watling & Gregory 1993)

***Galerina triscopa*** (Fr.) Kühner
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Tortić
Exs.: CNF

***Galerina unicolor*** (Vahl : Fr.) Singer
= *Pholiota unicolor* (Vahl : Fr.) Gillet (1)
Ref.: Škorić 1928 (1)

## *Gymnopilus* P. Karst.

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Gregory 1993)

***Gymnopilus bellulus*** (Peck) Murrill
Ref.: Tortić 1989
Exs.: CNF ?

•***Gymnopilus junonius*** (Fr. : Fr.) P.D. Orton
= *Gymnopilus spectabilis* (Weinm. : Fr.) A.H. Sm. (1)
Ref.: Tortić 1966 a (1), unp. Matočec (1), unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Watling & Gregory 1993)

•***Gymnopilus penetrans*** (Fr.) Murrill
= *Gymnopilus hybridus* (Fr.) Maire

Ref.: Tortić 1966 b, Tortić 1968 b, Tortić 1989, Tortić 1993, Tortić 1994, unp. Mešić & Tkalčec, unp. Tortić, Tortić 1966 a ?
Exs.: CNF
(Lit.: Moser 1983, Watling & Gregory 1993)

***Gymnopilus picreus*** (Pers. : Fr.) Gillet
Ref.: Tortić 1973, Tortić 1989, unp. Tortić
Exs.: CNF

*•***Gymnopilus sapineus*** (Fr. : Fr.) Maire
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Moser 1983, Watling & Gregory 1993)

## ***Hebeloma*** (Fr.) P. Kumm.

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Gröger 1987, Gröger & Zschieschang 1981, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Vesterholt 1989, Vouk & Pevalek 1916)

•***Hebeloma crustuliniforme*** (Bull.) Quél.
= *Agaricus crustuliniformis* Bull. (1)
= *Derminus crustuliniformis* (Bull.) J. Schröt. (2)
Ref.: Barčić 1982, Barčić 1996, Focht 1974, Focht 1979, Schulzer 1882 a (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Vouk & Pevalek 1916 (2), unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić, Tortić 1993 ?
Exs.: CNF
(Lit.: Moser 1983)

***Hebeloma longicaudum*** (Pers. : Fr.) P. Kumm. (sensu J.E. Lange)
Ref.: Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM

***Hebeloma mesophaeum*** (Pers.) Quél.
Ref.: Focht 1974, Tortić 1964, unp. Tortić
Exs.: CNF

•***Hebeloma radicosum*** (Bull. : Fr.) Ricken
= *Agaricus radicosus* Bull. : Fr. (1)
= *Pholiota radicosa* (Bull. : Fr.) P. Kumm. (2)
Ref.: Gjurašin 1898 (2), Lange 1974, Schulzer *& al.* 1866 (1), Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: BEO, CNF, Mrvoš (from Matočec), POZM
(Lit.: Hansen & Knudsen 1992, Moser 1983)

•***Hebeloma sacchariolens*** Quél.
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Gröger & Zschieschang 1981)

***Hebeloma sarcophyllum*** (Peck) Sacc.
Ref.: Stropnik *& al.* 1988, Focht 1986 HR?

*•***Hebeloma senescens*** (Batsch) Berk. et Broome
= *Hebeloma edurum* Métrod ex Bon (1)
Ref.: unp. Mešić & Tkalčec, unp. Tortić (1), Focht 1986 HR? (1), Tortić 1968 b ? (1)
Exs.: CNF
(Lit.: Moser 1983)

•***Hebeloma sinapizans*** (Paulet ex Fr.) Gillet
Ref.: Barčić 1982, Barčić 1984, Barčić 1996, Focht 1974, Focht 1979, Focht 1986, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF, POZM
(Lit.: Hansen & Knudsen 1992, Moser 1983)

*****Hebeloma velutipes*** Bruchet
Ref.: unp. Matočec
Exs.: Mrvoš (from Matočec)

MOST PROBABLY FOUND IN THE TERRITORY OF CROATIA

***Hebeloma album*** Peck (sensu Bruchet)
Ref.: Focht 1986 HR?

***Hebeloma birrum*** (Fr.) Gillet
Ref.: Focht 1986 HR?

***Hebeloma cistophilum*** Maire
Ref.: Focht 1986 HR?

***Hebeloma pallidum*** Malençon
Ref.: Focht 1986 HR?

## *Inocybe* (Fr.) Fr.

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Bresinsky 1989, Hansen & Knudsen 1992, Heim 1931, Kreisel 1987, Kuyper 1986, Stangl 1989, Stangl & Bresinsky 1981)

•***Inocybe adaequata*** (Britzelm.) Sacc.
= *Inocybe jurana* Pat. (1)
Ref.: Focht 1974 (1), unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Kuyper 1986)

***Inocybe asterospora*** Quél.
Ref.: Barčić 1982, Barčić 1996, Tortić 1973, unp. Tortić
Exs.: CNF

***Inocybe bresadolae*** Massee
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

***Inocybe cervicolor*** (Pers.) Quél.
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Tortić
Exs.: CNF

****Inocybe cookei*** Bres.
Ref.: unp. Tortić

***Inocybe corydalina*** Quél.
Ref.: Lisiewska & Tortić 1990, Tortić 1973, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM

•***Inocybe erubescens*** A. Blytt
= *Inocybe patouillardii* Bres. (1)
Ref.: Focht 1974 (1), Focht 1983 b (1), Tortić 1968 b (1), Tortić 1973 (1), unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Kuyper 1986, Stangl 1989)

***Inocybe fraudans*** (Britzelm.) Sacc.
= *Inocybe indissimilis* (Britzelm.) Sacc. (1)
= *Inocybe pyriodora* (Pers. : Fr.) P. Kumm. var. *incarnata* (Bres.) Maire (2)
Misappl.: *Inocybe pyriodora* (Pers. : Fr.) P. Kumm. sensu auct. non Pers. (3)
(sensu Pers. = ? *I. bongardii* (Weinm.) Quél. - Kuyper 1986)
Ref.: Barčić 1982 (3), Barčić 1996 (3), Focht 1983 b (2), Škorić 1928 (3), Vouk & Pevalek 1916 (1), unp. Tortić (3)
Exs.: CNF ? (3)

•***Inocybe geophylla*** (Sowerby : Fr.) P. Kumm.
= *Agaricus geophyllus* Sowerby : Fr. (1)
Ref.: Jelić & Tortić 1973, Schulzer 1882 a (1), Schulzer *& al.* 1866 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Tortić
Exs.: CNF

•var. ***geophylla***
= *Agaricus argillaceus* Pers. (2)
Ref.: Schulzer 1882 a (2), Schulzer *& al.* 1866 (2), unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Kuyper 1986)

•var. ***lilacina*** (Peck) Gillet
= *Inocybe geophylla* (Sowerby : Fr.) P. Kumm. var. *violacea* Pat. (3)
Ref.: Tortić 1966 a (3), unp. Tortić (3), unp. Mešić & Tkalčec

Exs.: CNF
(Lit.: Kuyper 1986)

•***Inocybe godeyi*** Gillet
Ref.: Tortić 1968 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Kuyper 1986)

***Inocybe hystrix*** (Fr.) P. Karst.
Ref.: Tortić 1973
Exs.: PRM

***Inocybe impexa*** (Lasch) Kuyper
= *Inocybe maritima* (Fr. →) P. Karst. (1)
Ref.: Focht 1974 (1)

***Inocybe jacobi*** Kühner
Ref.: Tortić 1973
Exs.: PRM

•***Inocybe lacera*** (Fr. : Fr.) P. Kumm.
= *Inocybe oblongispora* (Britzelm.) Sacc. et P. Syd. (1)
Ref.: Vouk & Pevalek 1916 (1)

*•var. ***helobia*** Kuyper
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Kuyper 1986)

****Inocybe langei*** R. Heim
Ref.: unp. Tortić

***Inocybe lanuginosa*** (Bull. : Fr.) P. Kumm.

var. ***ovatocystis*** (Boursier et Kühner) Stangl
= *Inocybe ovatocystis* Boursier et Kühner (1)
Ref.: Tortić 1973 (1)
Exs.: PRM (1)

***Inocybe margaritispora*** (Berk.) Sacc.
= *Inocybe phaeosticta* Furrer-Ziogas
Ref.: Focht 1986

****Inocybe petiginosa*** (Fr. : Fr.) Gillet
Ref.: unp. Tortić

***Inocybe praetervisa*** Quél.
Ref.: Lisiewska & Tortić 1990, unp. Tortić
Exs.: CNF

***Inocybe relicina*** (Fr. : Fr.) Quél.
Ref.: Vouk & Pevalek 1916

***Inocybe rimosa*** (Bull. : Fr.) P. Kumm.
= *Agaricus rimosus* Bull. : Fr. (1)
= *Inocybe brunnea* Quél. (2)
= *Inocybe fastigiata* (Schaeff.) Quél. (3)
= *Inocybe fastigiata* (Schaeff.) Quél. var. *umbrinella* Bres. (4)
= *Inocybe orbata* Malençon (5)
- as *Inocybe* "*vimosa*" Bull. (6)
Ref.: Focht 1974 (2)(3), Gjurašin 1898 (6), Lisiewska & Tortić 1990 (3), Schulzer 1882 a (1), Tortić 1966 a (4), Tortić 1966 b (4), Tortić 1968 b (3), Tortić & Lisiewska 1978 (3), Vouk & Pevalek 1916, unp. Tortić (3)(4), Focht 1983 b HR? (5), Schulzer 1857 HR? (1)
Exs.: CNF

***Inocybe sambucina*** (Fr. : Fr.) Quél.
= *Derminus sambucinus* (Fr. : Fr.) ? (1)
Ref.: Focht 1974, Škorić 1928 (1),Vouk & Pevalek 1915 (1)

***Inocybe splendens*** R. Heim

var. ***phaeoleuca*** (Kühner) Kuyper
= *Inocybe phaeoleuca* Kühner (1)
Ref.: Focht 1974 (1)

***Inocybe squamata*** J.E. Lange
Ref.: Barčić 1982, Barčić 1996, Focht 1974

***Inocybe terrigena*** (Fr.) Kuyper
Ref.: Focht 1974

***Inocybe whitei*** (Berk. et Broome) Sacc.
= *Inocybe geophylla* (Sowerby : Fr.) P. Kumm. var. *lateritia* (Weinm.) J.E. Lange (1)
= *Inocybe pudica* Kühner (2)
Ref.: Focht 1974 (1), Tortić 1966 a (2), Tortić 1966 b (2), unp. Tortić (2)
Exs.: CNF

## *Leucocortinarius* (J.E. Lange) Singer

(Lit.: Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Gregory 1993)

•***Leucocortinarius bulbiger*** (Alb. et Schwein. : Fr.) Singer
Ref.: Tortić 1968 b, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF, Mrvoš (from Matočec)
(Lit.: Hansen & Knudsen 1992, Watling & Gregory 1993)

## *Rozites* P. Karst.

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Watling & Gregory 1993)

•***Rozites caperatus*** (Pers. : Fr.) P. Karst.
= *Pholiota caperata* (Pers. : Fr.) P. Kumm. (1)
Ref.: Božac 1982 (1), Božac 1984, Božac 1986, Božac 1989, Božac 1993, Focht 1979, Gjurašin 1898 (1), Lange 1974, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Vouk & Pevalek 1916, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Watling & Gregory 1993)

## Familia **Hygrophoraceae** Roze ex Lotsy

### ***Hygrocybe*** (Fr.) P. Kumm.

(Lit.: Arnolds 1986 b, Arnolds *& al.* 1995, Bas *& al.* 1990, Boertmann 1996, Bollmann *& al.* 1996, Bon 1990, Candusso 1997, Clémençon 1982, Dennis *& al.* 1960, Fries 1821, Hansen & Knudsen 1992, Kreisel 1987, Ricken 1915, Schroeter 1889, Singer 1986)

•***Hygrocybe acutoconica*** (Clem.) Singer
= *Hygrocybe persistens* (Britzelm.) Singer (1)
= *Hygrophorus persistens* (Britzelm.) Britzelm. (2)
= *Hygrophorus rickenii* Maire (3)
Misappl.: *Hygrocybe crocea* (Bull.) Singer sensu auct. europ. non Bull. (4)
Ref.: Focht 1974 (1), Focht 1979 (2), Tortić 1966 a (3), Tortić 1973 (4), unp. Mešić & Tkalčec, unp. Tortić (4)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrocybe calyptriformis*** (Berk. et Broome) Fayod
Ref.: Tortić 1968 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

•***Hygrocybe cantharellus*** (Schwein. : Fr.) Murrill
= *Hygrocybe lepida* Arnolds
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

•***Hygrocybe ceracea*** (Fr. : Fr.) P. Kumm.
= *Hygrophorus ceraceus* (Fr. : Fr.) Fr. (1)
Ref.: Schulzer 1867 (1), Vouk & Pevalek 1916 (1), unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

•***Hygrocybe chlorophana*** (Fr. : Fr.) Wünsche
= *Hygrophorus chlorophanus* (Fr. : Fr.) Fr. (1)
Ref.: Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1994, Vouk & Pevalek 1916 (1), unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

***Hygrocybe citrinovirens*** (J.E. Lange) Jul. Schäff.
= *Hygrophorus citrinovirens* (J.E. Lange) Konrad et Maubl. (1)
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1973 (1), unp. Tortić
Exs.: CNF

•***Hygrocybe coccinea*** (Schaeff. : Fr.) P. Kumm.
Ref.: Barčić 1996, Tortić 1966 a, Tortić 1966 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

•***Hygrocybe conica*** (Schaeff. : Fr.) P. Kumm.
= *Hygrophorus conicus* (Schaeff. : Fr.) Fr. (1)
Misappl.: *Hygrocybe nigrescens* (Quél.) Kühner sensu auct. non Quél. (2)
Ref.: Barčić 1982 (2), Barčić 1996 (2), Focht 1974 ( )(2), Kranjčev 1995, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1994, Vouk & Pevalek 1916 (1), unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić (1)(2)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996, Candusso 1997)

*•***Hygrocybe flavipes*** (Britzelm.) Arnolds
= *Camarophyllus flavipes* (Britzelm.) Clémençon
= *Cuphophyllus flavipes* (Britzelm.) Bon
Misappl.: *Camarophyllus lacmus* (Schumach.) J.E. Lange sensu auct. non Schumach. (1)
Ref.: unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

*•***Hygrocybe fornicata*** (Fr.) Singer
= *Hygrocybe streptopus* (Fr.) Singer et Kuthan
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996, Candusso 1997)

•***Hygrocybe intermedia*** (Pass.) Fayod
= *Hygrophorus intermedius* Pass. (1)
Ref.: Focht 1979 (1), Tortić 1966 a, Tortić 1966 b, unp. Mešić & Tkalčec, unp. Tortić

Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

•***Hygrocybe irrigata*** (Pers. : Fr.) Bon
= *Camarophyllus unguinosus* (Fr. : Fr.) ? (1)
= *Hygrocybe unguinosa* (Fr. : Fr.) P. Karst. (2)
Ref.: Tortić 1973 (2), unp. Mešić & Tkalčec, unp. Tortić (1)(2)
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

•***Hygrocybe konradii*** R. Haller Aar.
Ref.: Tortić 1968 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997, Dennis *& al.* 1960)

*•***Hygrocybe lacmus*** (Schumach.) P.D. Orton et Watling
= *Camarophyllus lacmus* (Schumach.) J.E. Lange non sensu auct.
= *Cuphophyllus lacmus* (Schumach.) Bon
= *Camarophyllus subviolaceus* (Peck) Singer
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996, Candusso 1997)

•***Hygrocybe laeta*** (Pers. : Fr.) P. Kumm.
Ref.: Tortić 1973, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

***Hygrocybe miniata*** (Fr. : Fr.) P. Kumm.
= *Hygrophorus miniatus* (Fr. : Fr.) Fr. (1)
Misappl.: *Hygrophorus flammeus* (Scop.) J. Schröt. sensu J. Schröt. non Scop. (Schroeter 1889 as "*flammans*") (2)
Ref.: Focht 1972, Focht 1974, Focht 1979 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić 1994, Vouk & Pevalek 1915 (2), Vouk & Pevalek 1916 (2), unp. Tortić ( )(1)
Exs.: CNF

*•***Hygrocybe mucronella*** (Fr.) P. Karst.
= *Hygrocybe reai* (Maire) J.E. Lange
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996)

***Hygrocybe nitrata*** (Pers.) Wünsche
= *Hygrophorus nitratus* (Pers.) Fr. (1)
Misappl.: *Hygrocybe murinacea* (Bull. : Fr.) Moser sensu auct. non Bull. (2)
(sensu Bull. = ? *Porpoloma metapodium* (Fr. : Fr.) Singer - Arnolds 1986 b)

Ref.: Božac 1984 (1), Tortić 1973 (2), unp. Tortić
Exs.: CNF

•***Hygrocybe obrussea*** (Fr. : Fr.) Wünsche
= *Hygrocybe quieta* (Kühner) Singer (1)
Ref.: Božac 1984 (1), Božac 1989 (1), Božac 1993 (1), Candusso 1997, Tortić 1973, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: Candusso, CNF, PRM
(Lit.: Bas *& al.* 1990, Boertmann 1996, Candusso 1997)

•***Hygrocybe ovina*** (Bull. : Fr.) Kühner
= *Hygrocybe nitiosa* (A. Blytt) Moser (1)
Ref.: Tortić 1973 ( )(1), unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Boertmann 1996)

*•***Hygrocybe perplexa*** (A.H. Sm. et Hesler) Arnolds
Misappl.: *Hygrocybe sciophana* (Fr. : Fr.) Wünsche sensu auct. non Fr.
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996, Candusso 1997)

•***Hygrocybe pratensis*** (Pers. : Fr.) Murrill
= *Camarophyllus pratensis* (Pers. : Fr.) P. Kumm. (1)
= *Cuphophyllus pratensis* (Pers. : Fr.) Bon
= *Hygrophorus pratensis* (Pers. : Fr.) Fr. (2)
Ref.: Božac 1982 (2), Božac 1984 (1), Božac 1986 (1), Božac 1989 (1), Božac 1993 (1), Focht 1979 (2), Schulzer *& al.* 1866 (2), Tortić 1964 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 a (1), Tortić 1994 (1), unp. Matočec (1), unp. Tortić (1)(2)
Exs.: CNF

•var. ***pratensis***
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996)

*•var. ***pallida*** (Cooke) Arnolds
= *Hygrocybe berkeleyi* (P.D. Orton) P.D. Orton et Watling
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996)

•***Hygrocybe psittacina*** (Schaeff. : Fr.) P. Kumm.
= *Hygrophorus psittacinus* (Schaeff. : Fr.) Fr. (1)
Ref.: Focht 1974, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Vouk & Pevalek 1916 (1), unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996, Candusso 1997)

•***Hygrocybe punicea*** (Fr. : Fr.) P. Kumm.
= *Hygrophorus puniceus* (Fr. : Fr.) Fr. (1)
Ref.: Barčić 1982, Barčić 1984, Barčić 1996, Božac 1984, Božac 1986, Božac 1989, Božac 1993, Focht 1979 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić 1994, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

*•***Hygrocybe reidii*** Kühner
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

•***Hygrocybe russocoriacea*** (Berk. et T.K. Mill.) P.D. Orton et Watling
= *Camarophyllus russocoriaceus* (Berk. et T.K. Mill.) J.E. Lange (1)
= *Cuphophyllus russocoriaceus* (Berk. et T.K. Mill.) Bon
= *Hygrophorus russocoriaceus* Berk. et T.K. Mill. (2)
Ref.: Božac 1984 (1), Focht 1972 (2), Focht 1979 (2), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 a (1), unp. Mešić & Tkalčec, unp. Tortić (1), Focht 1986 HR? (1)
Exs.: CNF
(Lit.: Boertmann 1996, Candusso 1997)

*•***Hygrocybe spadicea*** (Scop.) P. Karst.
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrocybe virginea*** (Wulfen : Fr.) P.D. Orton et Watling
= *Agaricus virgineus* Wulfen : Fr. (1)
= *Camarophyllus virgineus* (Wulfen : Fr.) P. Kumm. (2)
= *Hygrophorus virgineus* (Wulfen : Fr.) Fr. (3)
= *Camarophyllus niveus* (Scop.) Wünsche (4)
= *Cuphophyllus niveus* (Scop.) Bon
= *Hygrophorus niveus* (Scop.) Fr. (5)
= *Agaricus virgineus* Wulfen : Fr. var. *niveus* (Scop.) Fr. (6)
= *Camarophyllus subradiatus* (Schumach.) Wünsche

•var. ***virginea***
Ref.: Focht 1979 (3), Schulzer *& al.* 1866 (3), Tortić 1964 (4), Tortić 1966 a (2)(4), Tortić 1966 b (2)(4), Tortić 1968 a (4), Tortić 1994 (4), unp. Mešić & Tkalčec, unp. Tortić (2)(4)(5), Focht 1986 HR? (4), Schulzer 1857 HR? (1)(6)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Boertmann 1996, Candusso 1997)

var. ***fuscescens*** (Bres.) Arnolds
= *Camarophyllus fuscescens* (Bres.) Moser (7)

Ref.: Tortić 1973 (7), unp. Tortić (7)
Exs.: CNF, PRM (7)

## *Hygrophorus* Fr.

(Lit: Arnolds 1986 a, Arnolds *& al.* 1995, Bas *& al.* 1990, Bollmann *& al.* 1996, Bon 1990, Candusso 1997, Hansen & Knudsen 1992, Kreisel 1987, Michael - Hennig - Kreisel 1977, Pilát 1951 b, Pilát & Ušák 1959, Singer 1986)

•***Hygrophorus agathosmus*** (Fr.) Fr.
= *Limacium agathosmum* (Fr.) Wünsche (1)
Ref.: Gjurašin 1898, Tortić 1973, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Candusso 1997)

*•***Hygrophorus arbustivus*** Fr.
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Candusso 1997)

*•***Hygrophorus aureus*** Arrh.
= *Hygrophorus hypothejus* (Fr. : Fr.) Fr. var. *aureus* (Arrh.) Imler
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Candusso 1997, Moser 1983)

*•***Hygrophorus calophyllus*** P. Karst.
= *Hygrophorus camarophyllus* (Alb. et Schwein. : Fr.) Dumée, Grandjean et Maire var. *calophyllus* (P. Karst.) Konrad et Maubl.
Ref.: unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Candusso 1997, Hansen & Knudsen 1992, Moser 1983)

*•***Hygrophorus camarophyllus*** (Alb. et Schwein. : Fr.) Dumée, Grandjean et Maire
= *Hygrophorus atramentosus* (Alb. et Schwein.) H. Haas et Haller ex Bon
= *Hygrophorus caprinus* (Scop.) Fr. (1)
Ref.: unp. Mešić & Tkalčec, Blagaić 1921 ? (1)
Exs.: CNF
(Lit.: Candusso 1997)

•***Hygrophorus capreolarius*** (Kalchbr.) Fr.
= *Limacium capreolarium* (Kalchbr.) Sacc. (1)
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Lindtner, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: BEO, CNF
(Lit.: Candusso 1997)

•***Hygrophorus chrysodon*** (Batsch : Fr.) Fr.
= *Limacium chrysodon* (Batsch : Fr.) P. Kumm. (1)
Ref.: Tortić 1964, Tortić 1966 a, Tortić 1966 b, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

****Hygrophorus discoideus*** (Pers. : Fr.) Fr.
Ref.: unp. Tortić
Exs.: CNF

•***Hygrophorus discoxanthus*** (Fr.) Rea
= *Hygrophorus chrysaspis* Métrod (1)
Misappl.: *Hygrophorus cossus* (Sowerby) Fr. sensu auct. p. p. non Sowerby (2)
(sensu Sowerby = nom. dub. - Arnolds 1986 a)
Ref.: Focht 1972 (2), Tortić 1966 a (1), Tortić 1968 b (1), Tortić 1993 (2), unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Bas *& al.* 1990)

•***Hygrophorus eburneus*** (Bull. : Fr.) Fr.
Misappl.: *Hygrophorus cossus* (Sowerby) Fr. sensu auct. p. p. non Sowerby
Ref.: Focht 1972, Tortić & Lisiewska 1978, unp. Mešić & Tkalčec, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1990)

***Hygrophorus eburneus*** (Bull. : Fr.) Fr. **sensu lato**
Incl.: *Hygrophorus discoxanthus* (Fr.) Rea
Misappl.: *Hygrophorus cossus* (Sowerby) Fr. sensu auct. p. p. non Sowerby
Misappl.: *Limacium cossus* (Sowerby) Wünsche sensu auct. p. p. non Sowerby (1)
*Hygrophorus eburneus* (Bull. : Fr.) Fr. (2)
= *Limacium eburneum* (Bull. : Fr.) P. Kumm. (3)
Misappl.: *Hygrophorus cossus* (Sowerby) Fr. sensu auct. p. p. non Sowerby
Misappl.: *Limacium cossus* (Sowerby) Wünsche sensu auct. p. p. non Sowerby (1)
Ref.: Blagaić 1921 (1), Gjurašin 1898 (2), Lorinser - Janda 1877 (2), Tortić 1964 (2), Tortić 1966 a, Tortić 1966 b, Vouk & Pevalek 1915 (3), Vouk & Pevalek 1916 (3), Schulzer *& al.* 1866 ? (2)

•***Hygrophorus erubescens*** (Fr. : Fr.) Fr.
Ref.: Gjurašin 1898, unp. Mešić & Tkalčec, unp. Tortić

Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrophorus hypothejus*** (Fr. : Fr.) Fr.
Ref.: Focht 1972, Focht 1981 a, unp. Mešić & Tkalčec, unp. Tortić, Focht 1986 HR?
Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrophorus latitabundus*** Britzelm.
Misappl.: *Hygrophorus limacinus* (Scop. : Fr.) Fr. sensu auct. non Scop. (1)
Misappl.: *Limacium limacinum* (Scop. : Fr.) Ricken sensu auct. non Scop. (2)
Ref.: Vouk & Pevalek 1915 (2), unp. Mešić & Tkalčec, Focht 1981 b HR? (1)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrophorus lindtneri*** Moser
= *Hygrophorus carpini* Gröger
= *Hygrophorus unicolor* Gröger
Misappl.: *Hygrophorus leucophaeus* (Scop.) Fr. sensu auct. non Scop. (1)
Ref.: Tortić 1964 (1), Tortić 1968 b (1), unp. Mešić & Tkalčec, unp. Tortić (1), Božac 1984 HR? (1)
Exs.: CNF
(Lit.: Candusso 1997)

•***Hygrophorus lucorum*** Kalchbr.
Ref.: Candusso 1997, Tortić 1968 b, unp. Mešić & Tkalčec, unp. Tortić
Exs.: Candusso, CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrophorus marzuolus*** (Fr. : Fr.) Bres.
Ref.: Božac 1982, Božac 1984, Božac 1986, Božac 1989, Božac 1993, Candusso 1997, Focht 1979, Focht 1981 a, Focht 1983 a, Focht 1986, Lange 1974, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić
Exs.: Candusso, CNF
(Lit.: Candusso 1997)

•***Hygrophorus nemoreus*** (Pers. : Fr.) Fr.
= *Limacium nemoreum* (Pers. : Fr.) Kühner (1)
- as *Hygrophorus "nemorosus"* Pers. (2)
Ref.: Focht 1979, Schulzer *& al.* 1866 (2) + Schulzer 1867, Tortić 1964, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF, POZM
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrophorus olivaceoalbus*** (Fr. : Fr.) Fr.
= *Limacium olivaceoalbum* (Fr. : Fr.) P. Kumm. (1)
Ref.: Vouk & Pevalek 1915 (1), unp. Mešić & Tkalčec
Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrophorus penarius*** Fr.
= *Limacium penarium* (Fr.) Wünsche (1)
= *Hygrophorus barbatulus* G. Becker (2)
Ref.: Tortić 1966 a (2), Tortić 1968 a (2), Tortić 1968 b, unp. Mešić & Tkalčec, unp. Tortić ( )(1)(2)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Hansen & Knudsen 1992, Moser 1983)

•***Hygrophorus persoonii*** Arnolds
= *Hygrophorus dichrous* Kühner et Romagn. (nom. inval.) (1)
= *Limacium dichroum* (Kühner et Romagn.) ? (2)
= *Agaricus limacinus* Schaeff. (3)
Ref.: Barčić 1982 (1), Barčić 1996 (1), Božac 1984 (1), Božac 1986 (1), Božac 1989 (1), Božac 1993 (1), Focht 1981 b (1), Mužic & Božac 1984 (1), Mužic & Božac 1997 (1), Tortić 1968 b (1), unp. Mešić & Tkalčec, unp. Tortić (1)(2), Schulzer 1857 HR? (3)
Exs.: CNF
(Lit.: Bas *& al.* 1990, Candusso 1997)

•***Hygrophorus poetarum*** R. Heim
= *Limacium poetarum* (R. Heim) Pilát (1)
Ref.: Tortić 1968 b, Tortić & Lisiewska 1978, unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Candusso 1997)

•***Hygrophorus pudorinus*** (Fr. : Fr.) Fr.
= *Limacium pudorinum* (Fr. : Fr.) Wünsche (1)
Ref.: Blagaić 1923 (1), Focht 1979, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Mešić & Tkalčec, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Candusso 1997)

•***Hygrophorus pustulatus*** (Pers. : Fr.) Fr.
= *Hygrophorus tephroleucus* (Pers. : Fr.) Fr. (1)
Ref.: Tortić 1973 (1), unp. Mešić & Tkalčec, unp. Tortić (1)
Exs.: CNF
(Lit.: Candusso 1997)

•***Hygrophorus russula*** (Schaeff. : Fr.) Fr.
= *Agaricus russula* Schaeff. : Fr. (1)
= *Limacium russula* (Schaeff. : Fr.) Ricken (2)
= *Tricholoma russula* (Schaeff. : Fr.) Gillet (3)

Ref.: Lorinser - Janda 1877 (3), Škorić 1928 (1), Tortić 1964, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Matočec, unp. Mešić & Tkalčec, unp. Tortić ( )(2)
Exs.: CNF, POZM
(Lit.: Candusso 1997)

# EXCLUDED RECORDS

## Familia **Agaricaceae** Fr.

***Agaricus arvensis*** Schaeff. : Fr. var. ***pretiosus*** Venturi = **?**
Ref.: Schulzer 1867

***Agaricus campester*** L. : Fr. var. ***cortinatus*** Schulzer = **?**
Ref.: Schulzer 1877

***Agaricus campester*** L. : Fr. var. ***fulvaster*** Viv. = **?**
Ref.: Schulzer *& al.* 1866

***Agaricus campester*** L. : Fr. var. ***gracilipes*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

***Agaricus campester*** L. : Fr. var. ***radicosus*** Viv. = **?**
Ref.: Schulzer 1857 HR?

***Agaricus cretaceus*** Bull. : Fr. - nom. conf. (Candusso & Lanzoni 1990)
= *Psalliota cretacea* (Bull. : Fr.) P. Kumm. (1)
Ref.: Blagaić 1921 (1), Blagaić 1931 (1), Kišpatić 1950 (1), Schulzer 1857 HR?

***Agaricus edulis*** "Pers." var. ***cylindriformis*** Schulzer = **?** [*Psalliota*]
Ref.: Schulzer 1879

***Agaricus laevis*** Krombh.
Ref.: Schulzer *& al.* 1866, Schulzer 1883 HR?
Annotation: According to Pilát (1951 b) it is a syonym of *Lepiota naucina* (Fr.) P. Kumm. (today *Leucoagaricus leucothites* (Vittad.) Wasser). Since Pilát (1951 b) has a very broad species concept of *L. naucina*, we cannot interpret Krombholz's species in a modern sense on the ground of Pilát's opinion.

***Agaricus letellieri*** Schulzer = **?** [*Lepiota*]
Ref.: Schulzer 1883 HR?

***Agaricus mancus*** Schulzer = **?** [*Chitonia*]
Ref.: Schulzer 1878

***Agaricus naucinoides*** Schulzer = **?** [*Lepiota*]
Ref.: Schulzer 1880

***Agaricus pelta*** Schulzer = **?** [*Lepiota*]
Ref.: Schulzer 1870

***Agaricus pometorum*** (Schulzer) Schulzer = **?**
= *Agaricus campester* L : Fr. var. *pometorum* Schulzer (1)
Ref.: Schulzer 1879 (1), Schulzer 1881

***Agaricus suaviodorus*** Schulzer = **?** [*Psalliota*]
Ref.: Schulzer 1880

***Lepiota gracilenta*** (Krombh.) Quél. var. ***queletii*** Schulzer = **?**
Ref.: Schulzer 1885, Saccardo 1887 HR?

***Lepiota hispida*** (Lasch) Gillet - nom. ambig.
Ref.: Blagaić 1921 ?

***Lepiota schulzeri*** (Kalchbr.) Sacc.
= *Agaricus schulzeri* Kalchbr. (1)
Ref.: Kalchbrenner & Schulzer 1873-1877 (1), Fries 1874 HR? (1), Saccardo 1887 HR?
Annotation: According to Pilát (1951 b) it is a syonym of *Lepiota naucina* (Fr.) P. Kumm. (today *Leucoagaricus leucothites* (Vittad.) Wasser). Since Pilát (1951 b) has a very broad species concept of *L. naucina*, we cannot interpret Kalchbrenner's species in a modern sense on the ground of Pilát's opinion.

***Schulzeria rimulosa*** Schulzer et Bres. = **?**
Ref.: Bresadola 1886, Saccardo 1887

***Schulzeria squamigera*** Schulzer et Bres. = **?**
Ref.: Bresadola 1886, Saccardo 1887

## Familia **Amanitaceae** R. Heim ex Pouzar

***Agaricus inbulbosus*** Schulzer [*Amanita*]
Ref.: Schulzer 1881
Annotation: Gilbert (1940-1941) quotes this name as a possible synonym of *Amanita phalloides* (Vaill. ex Fr. : Fr.) Link.

***Agaricus minuteverrucosus*** Schulzer [*Amanita*]
Ref.: Schulzer 1881
Annotation: Gilbert (1940-1941) quotes this name as a possible synonym of *Amanita phalloides* (Vaill. ex Fr. : Fr.) Link.

***Agaricus phalloides*** Vaill. ex Fr. : Fr. var. ***bulbosus*** (Bull.) ? - nom. conf. (Gilbert 1940-1941)
Ref.: Schulzer *& al.* 1866

***Agaricus vaginatus*** Bull. : Fr. var. ***albidus*** Fr. - nom. conf. (nom. illeg.)
Ref.: Schulzer *& al.* 1866
Annotation: This variety partly represents *Amanita nivalis* Grev., and partly *A. vaginata* (Bull. : Fr.) Lam. var. *alba* (De Seynes) Gillet (Fraiture 1993).

***Agaricus vaginatus*** Bull. : Fr. var. "**d. - p. spadiceo**" Fr. 1821 = **?**
Ref.: Schulzer 1857 HR?

***Amanita bulbosa*** (Bull.) ? - nom. conf. (Gilbert 1940-1941, Parrot 1960)
Ref.: Škorić 1928, Vouk & Pevalek 1915, Vouk & Pevalek 1916

***Amanita bulbosa*** (Bull.) ? var. ***albida*** J. Schröt. = **?**
Ref.: Vouk & Pevalek 1916

***Amanita bulbosa*** (Bull.) ? var. ***grisea*** J. Schröt. = **?**
Ref.: Vouk & Pevalek 1916

***Amanita cariosa*** (Fr.) Quél.
Ref.: Škorić 1928
Annotation: This is a doubtful species. Some authors consider it an autonomous species (Merlo & Traverso 1983, Parrot 1960), some consider it a synonym of *Amanita excelsa* (Fr. : Fr.) Bertillon (Gilbert 1940-1941), while some consider it a synonym of *A. pantherina* (DC. : Fr.) Krombh. (Dennis *& al.* 1960).

***Amanita vaginata*** (Bull. : Fr.) Lam. var. ***nivea*** ? = **?**
Ref.: Focht 1979

***Amanitopsis cygnea*** (Schulzer) Sacc.
Ref.: Saccardo 1887
Annotation: Author of the quote specified Slavonia (part of Croatia today) as a locality, but Schulzer found the species in the part of former Slavonia that nowadays does not belong to Croatia.

## Familia **Cortinariaceae** R. Heim ex Pouzar

***Agaricus angulososporus*** Schulzer = **?** [*Inocybe*]
Ref.: Schulzer 1879

***Agaricus descissiformis*** Schulzer = **?** [*Inocybe*]
Ref.: Schulzer 1881

***Agaricus hypnorum*** Schrank : Fr. var. ***infantulus*** Schulzer = **?**
Ref.: Schulzer 1877

***Agaricus minusculus*** Schulzer = **?** [*Inocybe*]
Ref.: Schulzer 1880

***Agaricus peracutus*** Schulzer = **?** [*Inocybe*]
Ref.: Schulzer 1879

***Agaricus pulvinatulus*** Schulzer = **?** [*Inocybe*]
Ref.: Schulzer 1880

***Agaricus subrimosus*** Schulzer = **?** [*Inocybe*]
Ref.: Schulzer 1881

***Agaricus uncinatipes*** Schulzer = **?** [*Inocybe*]
Ref.: Schulzer 1881

***Cortinarius armillatus*** (Fr. : Fr.) Fr. var. ***canopodius*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

***Cortinarius barbarossa*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

***Cortinarius bresadolae*** Schulzer = **?**
Ref.: Saccardo 1887, Schulzer 1885

***Cortinarius cibaliensis*** Schulzer = **?**
Ref.: Schulzer 1879

***Cortinarius friesii*** Bres. et Schulzer
Ref.: Saccardo 1887, Schulzer 1885
Annotation: Moser (1960) considers that it could be identical to *Cortinarius praestans* (Cordier) Gillet.

***Cortinarius interamniensis*** Schulzer = **?**
Ref.: Schulzer 1879

***Cortinarius leucopodius*** (Bull.) J. Schröt. = **?**
Ref.: Vouk & Pevalek 1915

***Cortinarius sublanatus*** (Sowerby : Fr.) Fr.
Ref.: Vouk & Pevalek 1916
Annotation: This epithet has been misapplied for *Cortinarius cotoneus* Fr. (sensu Boud., Konrad et Maubl., Ricken). According to Dennis *& al.* (1960), Fries has misapplied this epithet for *C. pholideus* (Fr. : Fr.) Fr. We do not know in which sense the authors of the record have used this name.

***Cortinarius subzonatus*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

***Cortinarius uraceus*** Fr. var. ***bresadolae*** Schulzer = **?**
= *Agaricus conveniens* Schulzer (1)
Ref.: Schulzer 1877 (1), Schulzer 1885, Saccardo 1887 HR?

***Cortinarius validus*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

***Derminus sterilis*** (Jungh.) ? = **?**
Ref.: Škorić 1928

***Galera mycenopsis*** (Fr.) Quél.
= *Agaricus pannosus* Fr. : Fr. var. *rufisporus* Schulzer (1)
= *Agaricus vexans* Schulzer (2)
Ref.: Schulzer 1877 (1), Schulzer 1881 (2), Schulzer 1885
Annotation: This epithet has been misapplied for *Galerina pumila* (Pers. : Fr.) M. Lange ex Singer by many authors, but also for *G. mniophila* (Lasch : Fr.) Kühner by Cooke and Rea. We do not know in which sense the author of the records has used this name.

***Galerina unicolor*** (Vahl : Fr.) Singer var. ***muscigena*** Heim = **?**
Ref.: Focht 1972

***Gymnopilus stabilis*** (Weinm.) Kühner et Romagn. ex P.D. Orton
Ref.: Tortić 1966 a ?
Annotation: The author himself doubted his identification.

***Hebeloma elatum*** (Batsch : Fr.) Gillet
= *Derminus elatus* (Batsch : Fr.) Henn. (1)
Ref.: Vouk & Pevalek 1916 (1)
Annotation: This is a doubtful species (Dennis *& al.* 1960, Kreisel 1987).

***Hebeloma fastibile*** (Pers. : Fr.) P. Kumm.
= *Agaricus fastibilis* Pers. : Fr. (1)
= *Inocybe fastibilis* (Pers. : Fr.) Roze (2)
Ref.: Schulzer *& al.* 1866 (1), Vouk & Pevalek 1916 (2)
Annotation: This species is interpreted in a few different senses (see Arnolds *& al.* 1995, Bollmann *& al.* 1996, Kreisel 1987). We do not know which sense has been used by the author of the quote.

***Hebeloma queletii*** Schulzer = **?**
Ref.: Saccardo 1887, Schulzer 1885

***Hebeloma sinuosum*** (Fr.) Quél.
= *Inocybe sinuosa* (Fr.) P. Karst. (1)
Ref.: Vouk & Pevalek 1916 (1), Focht 1986 HR?
Annotation: This is a doubtful species (Vesterholt 1989).

***Inocybe destricta*** (Fr.) Quél. - nom. dub. (Dennis *& al.* 1960, Kuyper 1986)
Ref.: Vouk & Pevalek 1916

***Inocybe fibrosolacerata*** (Britzelm.) Sacc. et P. Syd. - nom. dub. (Kuyper 1986)
Ref.: Vouk & Pevalek 1916

***Inocybe lucifuga*** (Fr. : Fr.) P. Kumm. - nom. dub. (Kuyper 1986)
Ref.: Vouk & Pevalek 1916

***Inocybe scabra*** (O.F. Müll. : Fr.) P. Kumm.
Ref.: Vouk & Pevalek 1916
Annotation: According to Kuyper (1986), this species in the original, O. F. Müller's sense does not belong to the genus *Inocybe*. Although few authors have misapplied this name for *Inocybe corydalina* Quél., we do not know in which sense the authors of the record have used this name.

***Phlegmacium eufulmineum*** (Rob. Henry) Moser sensu Singer = **?**
Ref.: Focht 1974

## Familia **Hygrophoraceae** Roze ex Lotsy

***Hygrocybe citrina*** (Rea) J.E. Lange - nom. ambig. (Bas *& al.* 1990, Boertmann 1996, Bon 1990)
Ref.: Barčić 1982, Barčić 1984, Barčić 1996

***Hygrophorus diversipes*** Schulzer - nom. nud.
= *Hygrophorus flammeolus* Schulzer (nom. nud.) (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867

***Hygrophorus niveus*** (Scop.) Fr. var. ***fumidus*** Schulzer = ?
Ref.: Schulzer 1879

***Hygrophorus radiosostriatus*** Schulzer - nom. nud.
= *Hygrophorus striatus* Schulzer (nom. nud.) (1)
Ref.: Schulzer *& al.* 1866 (1) + Schulzer 1867

***Hygrophorus subcartilagineus*** Schulzer = **?**
Ref.: Schulzer 1879

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# BOOK REVIEWS AND NOTICES

Compiled by
**David L. HAWKSWORTH**[1]
*MycoNova, Calle Aguila 12, Colonia La Maliciosa, Mataelpino, E-28411 Madrid, Spain; and*
*Departamento de Biología Vegetal II, Facultad de Farmacia, Universidad Complutense,*
*Plaza de Ramón y Cajal, Ciudad Universitaria, E-28040 Madrid, Spain.*

## GENERAL

**Glossary of Mycology.** By J. G. Vaidya & P. Y. Lamrood. 2001. Satyajeet Prakashan, B-7 Arharvaved, S. N. 28/9, Kothrud, Pune 411029, India. Pp. iv + 473. ISBN 81 600565 6 5. Price Rs 300, US $ 30. CD US $ 10 (including postage).

With the costs of books published in the west continuing to spiral, the need for low-cost mycological works in less developed countries has never been greater. This new glossary has been put together by Dr J. G. Vaidya, a Professor of Botany at the University of Pune, and Mr Prasad Lambrood, a research student. The Glossary is stated in the Preface to be a 'mere compilation of over 25 to 30 glossaries either in print form or on Internet'. The identifies of the works used is not, however, stated, although it clearly includes texts such as *Ainsworth & Bisby's Dictionary of the Fungi* (though not the most recent edition) and there are no direct literature references within the entries. However, 'see Hawksworth' does appear not infrequently - but with no indication of which of my works is intended! The Glossary is divided into two alphabetical series: Part I (approx 4500 terms) comprises 'Terms used in mycological literature'; and Part II (approx 2650 terms) is devoted to 'Terms used in multidisciplinary studies of fungi'. Generic and higher taxon names are not included.

Where different definitions of the same term have been found, all may be listed even if only slightly varied in their wordings and being substantively the same. In some cases nine or more such alternatives are presented. Within Part I, usages of the same terms by mycologists and definitions from other fields are placed together. Part II has terms from extremely wide-ranging fields and it is not clear how the selection was made; many relate to medicine or human anatomy.

The production of a low-cost CD will undoubtedly prove popular, and I found this easy to install and use (7522 entries).

This is very much a hotch-potch, very easy to criticise, and certainly no alternative to the more critically produced mycological glossaries and dictionaries already available. However, provided that it is taken as a 'mere compilation' and not relied on as either exhaustive or infallible, it will fill a need and come to be widely used by those without access to other more reliable sources.

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Books for consideration for coverage in this column should be mailed to the Book Review Editor at MycoNova (address above) in the first instance. Fax (+34) 91 857 3649; e-mail: davidh@farm.ucm.es or myconova@terra.es

**Pictorial Atlas of Soil and Seed Fungi. Morphologies of cultured fungi and key to species**. By Tsuneo Watanabe. 2002. 2nd edn. CRC Press, 2000 N.W. Corporate Boulevard, Boca Raton, Florida 33431, USA. ISBN 0 8493 1118 7. Price US $ 129.95.

To endeavour to address the identification of soil and seed-borne fungi in a single volume is a daunting task. The first edition of this work was published in Japanese in 1993, and the first English edition issued in 1994. The book must have met some need to make a new edition worthwhile for the publishers, but this is not easy to explain. With so many works now available on soil or seed-borne fungi, the niche for this new edition must be questioned. Some 350 species are treated, with keys to genera and species within genera when they include more than three species. The claim that the work includes species 'illustrated in brilliant detail' must, however, be questioned; the photographs are often not sharply in focus, are not taken using phase or interference contrast optics, and the line drawings are extremely diagrammatic, small, and do not show details of key features of, for example, conidiogenous cells, asci, or ascospore germ-pores.

The selection of species is based on taxa which the author has isolated and identified in Japan and details of his collections are included. However, how representative are they of species to be expected by, for example, mycologists surveying soil fungi ? The inescapable answer is that they are not. For instance, in *Aspergillus* only six species are included, two of which are identified only to section; this compares with, for example, 19 soil species treated in detail in Domsch *et al.* (1980) and 26 in Moubasher (1993). Another problem for the beginner is that no information as to the numbers of species in particular genera is given so that there will be a tendency of users to "squeeze" isolates into the species that happen to be described.

References to original places of publication are given, and also to key descriptive literature. I do, however, worry about the accuracy of some citations when see author citations such as 'G*loeocercospora* Bain & Edgerton : Deighton' instead of 'D. C. Bain & Edgerton ex Deighton'.

Despite the claim on the back cover, explanations of methods are scant, and scarcely compete with, for example, those compiled by Davet & Rouxel (1997).

I fear that this is not a work that can be recommended, and it is difficult to understand why such a well-known mycological publisher should have accepted it. If it has any niche it is as an overview of the author's own work The danger is that because it is from such a publisher and highly priced, it is likely to be treated as authoritative. The result will be more erroneous determinations to compound a literature already bedevilled by misidentifcations.

Davet, P. & Rouxel, F. (1997) *Detection and Isolation of Soil Fungi.* Enfield, NH: Science Publishers.

Domsch, K. H., Gams, W. & Anderson, T.-H. (1980) *Compendium of Soil Fungi.* Vol. 1. London: Academic Press.

Moubasher, A. H. (1993) *Soil Fungi in Qatar and other countries.* Doha: Qatar University Press.

## ASCOMYCETES

**Monograph of the Monocotyledon-inhabiting Species of *Lophodermium***. By Peter R. Johnston. 22 January 2001. [Mycological Papers No. 176.] CABI Publishing, CAB International, Wallingford, Oxon OX10 8DE, UK. Pp. 239. ISBN 0 85199 558 6. Price £ 53, US $ 95.

*Lophodermium* species are generally thought of primarily as needle-fungi of conifers, but a wide array of these fungi occur on the stems and leaves of other plants, especially monocotyledons such as bamboos, grasses, pandans, and sedges. The species separations of *Lophodermium* and similar fungi on these hosts have been recognized as problematic at least since Terrier's observations in the 1940s, not least because of uncertainties as to the extent of the influence of the host tissues of the shape of the lirelliform ascomata. While the systematics of the economically important members of the genus occurring on conifers have been critically re-appraised over the last 20 years, especially since the revision of species on pines by Minter (1981), those on other hosts have generally been passed by. Now, Peter Johnston of Landcare Research in Auckland, already recognized as one of the leading world authorities on *Rhytismataceae,* has taken up this challenge.

Rather than just plunging-in and presenting his conclusions, the author starts with a critical and particularly well-illustrated discussion of the anatomical and morphological features of these fungi. This leads to the recognition of five groups of taxa and also some "miscellaneous" species. The groups differ in features such as the tissue type of the ascomatal primordial, presence or absence or nature of gelatinous sheaths on the ascospores, immersed or erumpent ascomata, and the excipular structure. A cladistic study, essentially based on the states of 20 anatomical features, was attempted in order to test the robustness of the groups but this was rather inconclusive except for supporting the adoption of *Terriera* – a genus introduced by B. Eriksson in 1970 but hardly used since. The genus differs from *Lophodermium* primarily in having a *textura intricata* primordium, and paraphyses with swollen ends forming an epithecium; the genus appears to be mainly tropical with most species from monocotyledons in the tropics belonging here. Eighteen taxa are referred to *Terriera* here. Three of the other groups are closely allied to different *Coccomyces* species, notably *C. coronatus, C. tumidulus* (the type species of the genus), and Southern Hemisphere species on dicotyledons.

Overall, 24 species are retained in *Lophodermium* of which six are newly described. These and the species accepted in *Terriera* are clearly keyed out, and the treatment of each is accompanied by detailed descriptions, information on synonyms, and first-rate photographs of macro- and microsopical features as well as line drawings of asci, ascospores, and paraphyses.

This monograph is sure to remain the standard reference work on these fungi for decades, and the author is to be congratulated on bringing this much-needed revision to completion.

Minter, D. W. (1981) *Lophodermium* on pines. *Mycological Papers* **147**: 1-54.
Terrier, C. A. (1942) Essai sur la systématique des *Phacidiaceae* (Fr.) *sensu* Nannfeldt (1932). *Beiträge zur Kryptogamen-Flora der Schweiz* 9(2): 1-99.

## LICHEN-FORMING FUNGI

**Flora of Australia. Vol. 58A. Lichens 3.** Edited by Patrick M. McCarthy. August 2001. [Australian Biological Resources Study.] CSIRO Publishing, 150 Oxford Street, P. O. Box 1139, Collingwood 3066, Victoria, Australia. Pp. xviii + 242, figs 59, col. Plates 56, maps 256. ISBN 0 643 06713 2 (hardback) or 0 643 06712 4 (paperback). Price A$ 85 (hardback) or A$ 70 (paperback).

Seven years have elapsed since the publication of the last volume on lichens in this series in 1994. The original plan was to have five volumes in a systematic arrangement, but now the policy of publishing ten smaller volumes made of accounts as they are completed has been adopted. The present volume thus contains treatments of a mix of families belonging to a variety of orders: *Arthrorhaphidaceae* (W. Obermayer), *Baeomycetaceae* (J. Johnston), *Icmadophilaceae* (J. Johnston), *Lichinales* (B. Büdel), *Lobariaceae* (D. J. Galloway, G. Kantvilas & J. A. Elix), *Myeloconaceae* fam. nov. (P. M. McCarthy), *Sphaerophoraceae* (M.

Wedin), *Trichotheliaceae* (P. M. McCarthy), and *Verrucariaceae* (P. M. McCarthy & O. Breuss).

The accounts are beautifully and painstakingly executed, with full bibliographic citations, details of types, illustrations, full descriptions, data on chemistry (where appropriate), habitat information, and distribution maps. Details of collections studied are provided in full for rarer species, and references to pertinent literature are given under the generic descriptions. The treatment of the *Verrucariaceae* is accompanied by first-rate line drawings, and a key feature of the work is the 56 colour plates, many of which (particularly those taken by William M. Malcolm) are stunning. Keys are provided for species within genera, but of especial value is the lucid key to all genera of crustose pyrenocarpous lichens in Australia (P. M. McCarthy); this will be of immense value to newcomers to lichenology not only in Australasia but in tropical areas generally.

McCarthy accepts an amazing 74 species of *Porina* and 34 of *Verrucaria*; the keys to these genera will have wide appeal as these are the largest numbers of species keyed out in these genera in recent years. Six new pyrenocarpous species are formally described.

The authors, and particularly the editor and his team, are to be congratulated on bringing this volume to fruition - and we now eagerly await the fourth instalment. My only pleas are that a simpler numbering system be adopted, and that the lichen volumes be incorporated into the *Fungi of Australia* series rather than the *Flora of Australia* – the present situation being quite out of step with current thinking on the biology and classification of lichen-fungi.

***Hypotrachyna* (*Parmeliaceae*) and allied genera in Papua New Guinea.** By Simone H. J. J. Louwhoff and John A. Elix. June 2002. [Bibliotheca Lichenologica No. 81.] J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany. Pp. 149, figs 76. ISBN 3 443 58060 2. Price € 58.

*Hypotrachyna* and *Parmotrema* are the most speciose parmelioid genera in the tropics. *Parmotrema* in Papua New Guinea was treated by the authors in 1999 (Louwhoff & Elix 1999), and the present title is the counterpart on *Hypotrachyna.* The work starts with a detailed history of the shifting taxonomic opinions on the rank and position of these lichens, and also an overview of the characters used in their classification. They state that 'phylogenetic analyses and molecular studies have largely supported the existing generic classification of the *Parmeliaceae*' (p. 10), but while that is true for some genera, more recent molecular work than that cited suggests that the generic concept of genera such as *Hypotrachyna* needs to be reassessed (Crespo *et al.* 2001).

This account, based on about 400 collections made by P. Diederich, H. Streiman, H. J. M. Sipman and J. A. Elix, also treats *Myelochroa, Parmelinella,* and *Parmelin-opsis,* genera largely separated on the basis of the nature of cilia and rhizines. The species in the four genera are keyed out in a single key in which chemical characters have a pre-eminent role. Treatments of individual species are excellent, including citations of the original literature and types, full morphological descriptions as well as data on chemistry, distribution and habitat, references to illustrations, notes, and full details of specimens studied. Habit photographs (half-tones) and distribution maps are also provided

In all, 49 species are accepted from the country, of which six are described as new. As many of the species have wide distributions not only in the tropics but some extending into temperate regions, this work will be of interest to a wide spectrum of lichenologists.

Crespo, A., Blanco, O. & Hawksworth, D. L. (2001) The potential of mitochondrial DAN for establishing phylogeny and stabilising generic concepts in the parmelioid lichens. *Taxon* **50**: 807-819.

Louwhoff, H. J. J. & Elix, J. A. (1999) *Parmotrema* and allied lichen genera in Papua New Guinea. *Bibliotheca Lichenologica* **73**: 1-152.

**Die lichenisierten Pilze Österreichs – eine Checkliste der bisher nachgewiesenen Arten mit Verbreitungsangaben.** By Josef Hafellner & Roman Turk. 31 May 2001. [Stapfia No. 76.] Biologiecentrum des Oberösterreichischen Landesmuseums, J.-W. Klein-Strasse 73, 4040 Linz, Austria. Pp. 167, figs 8. ISSN 0252-192X. Price not indicated.

This is not merely an impressive national checklist, with 2101 lichenized species accepted (non-lichenized lichenicolous taxa are not covered), but a work in which various new taxonomic proposals are made. In particular, seven genera are described as new: *Aspilidea* (for *Aspicilia myrinii*), *Bryodina* (for two species previously placed in *Bryonora*), *Calvitimela* (for three species formerly included in *Tephromela*), *Myxobilimbia* (for four species, the former *Bacidia sabuletorum* group), *Protomicarea* (for *Lecidella borealis*), *Pycnora* (for *Hypocenomyce xanthococca* and two other species), and *Timdalia* (for *Acarospora intricata*). The diagnostic features of the new genera mostly relate to how the asci stain in Lugol's iodine solution, and in the line drawings presented these appear to be distinctive. In addition, one new species, five new names, and numerous new combinations are proposed. Some of these will certainly cause some debate, such as the transfer of *Lecanora muralis* to *Protoparmeliopsis*, the acceptance of *Bagliettoa* (for the *Verrucaria baldensis* group), *Lobarina* (for *Lobaria scrobiculata*), and *Pseudosagedia* (for the *Porina chlorotica* group). This is especially so as there is no discussion presented to justify such changes; perhaps the arguments will be presented elsewhere? While I am personally not one of those who thinks changes should ever be newly introduced in checklists or regional floras (quite a few 'old' but neglected genera were resurrected without comment in the 1980 British checklist), acceptance will be hindered if the reasons for a change are not exposed. Amongst the macrolichens, I was surprised to see *Bryoria crispa, B. motykana,* and *B. positiva* accepted as species not as synonyms of *B. fuscescens*, again without discussion. For each species, selected synonyms, distribution in the country (by district), and information on altitudinal ranges and substrata are also provided. However, there are no references to pertinent literature within the body of the checklist so it is not possible to locate the source of records immediately or revisions of the taxa. Synonyms are usefully cross-referenced, but there is no epithet or other index. In view of the large number of novel changes introduced, this 'checklist' will need to be studied carefully by all preparing national checklists or otherwise concerned with generic concepts in crustose lichens.

## BASIDIOMYCETES

**Family *Agaricaceae* (Fr.) Cohn of Israel Mycobiota I. Tribe *Agariceae* Pat.** By Solomon P. Wasser. 2002. [Biodiversity of Cyanoprocaryotes, Algae and Fungi of Israel No.3.] A. R. G. Gantner Verlag Kommandit Gesellschaft, Fl 9491 Ruggell. [Distributed by Koeltz Scientific Books, Herrnwaldstrasse 6, D-61462 Königstein, Germany.] Pp. 212, figs 74. ISBN 3 904144 87 1. Price € 98.

The previous two volumes in this series concerned 'Cyanoprocaryotes and Algae of Continental Israel' (E. Nevo & S. P. Wasser, eds, 2000) and 'Soil Microfungi of Israel' (C. V. Subramanian & S. P. Wasser, eds, 2001; reviewed in *Mycotaxon* **82**, 2002). One cannot but marvel at the breadth and depth of Solomon's expertise! Here, however, he is back on his favourite territory. agarics. His love and enthusiasm for these fungi is evident from the substantial introductory sections which occupy almost a third of the book. Of especial interest here is the development of his pioneering ideas of angular parameters of basidia, based on studies of 100 basidia of 17 species from a wide range of genera in the family (not only from tribe *Agariceae*). Molecular, chemical, and cultural studies are reviewed, and in addition the system to be adopted for the whole family is presented; this includes four tribes (*Agariceae, Cystodermateae,* *Leucocoprineae*, and *Lepioteae*). The sectional systems adopted within genera will also be of wide interest to agaricologists, although it will be interesting to see how these compare with molecular phylogenies as more such data becomes available.

Four genera are treated: *Melanophyllum* (1 species), *Agaricus* (39 species), *Gymnophragmium* (2 species), and *Endoptychum* (1 species). *Allopsalliota* Nauta 1998 is treated as a synonym of *Agaricus* and viewed as an 'example of describing a new genus only to enrich the synonyms of . . . *Agaricus*'. The author claims that if similar criteria are used, 'all 200 species of genus *Agaricus* can be a basis for 200 new genera' (p. 78). Impressive lists of synonyms are presented, and while it is evident from the list of herbaria consulted (p. 9) that many types must have been examined, it would have been helpful to have these detailed. Full descriptions are provided, with information on world distributions, notes, and details of Israeli specimens studied. Line drawings of pileal cuticular elements, basidia and basidiospores are provided for most species, and in some cases accompanied by scanning electron micrographs and habit sketches. While habitat photographs or paintings are not presented, there are references to other published illustrations.

This is much more than a regional survey, and will need to be consulted by all specialists working on the *Agariceae*.

**Mushrooms of Hawai'i. An identification guide.** By Don E. Hemes & Dennis E. Desjardin. July 2002.Ten Speed Press, P. O. Box 7123, Berkley, CA 94707, USA. Pp. xii + 212, col. plates. ISBN 1 58008 339 0. Price US $ 39.95.

What a delightful book! And written by two leading mycologists with unrivaled knowledge of the macromycetes of Hawai'i. The introductory chapters are especially informative and include historical aspects, with references to original papers, information on collecting sites. Information on how to collect is provided, including a colour guide sample, spore prints, examination procedures, and work sheets (with measurements, sketches, etc).

Although not the first mushroom guide to be arranged by habitat, this is the first I have seen that does this for an essentially tropical region. This is immensely practical, especially when the habitats selected are rather precise: here they include, for example, compost piles and wood chips, flowerpots, guava thickets, coastal coconut, montane *Casuarina* forests, and arid leeward coastal habitats. Coloured flags on the page margins facilitate finding the pertinent sections quickly.

The authors have found 310 species of agarics in the islands since their detailed surveys started in the early 1990s. Interestingly, 94 % are saprotrophs and only 6 % ectomycorrhizal (and associated with alien trees). A remarkable 258 species appear to be. introductions, and 46 of 52 native species are putative endemics – a level of 88 % endemism in the islands' native agarics. Over 200 species are illustrated, many for the first time photographically, a surprisingly high proportion of those so far recorded. In addition to a fine coloured photograph, each species is accompanied by a small-type description, and notes about the habitat, frequency, edibility, separation from similar species, and information as to the islands it is recorded from.

But the book does not stop here. There are short accounts of rusts, lichens, slime moulds, and mycophagy, followed by chapters on poisonous, hallucinogenic and medicinal species, culturing mushrooms at home, and edible fungi (including recipes). Scientific names have been used in the main text, but a list of Hawaiin names and terms is also presented along with a traditional glossary and selected but wide-ranging bibliography.

This book will do much to promote enthusiasm for mycology in Hawai'i and the authors and publishers are to be congratulated on its realization. However, it merits attention not only from mycologists visiting the islands, but those contemplating their own introductory guides who may gain ideas on presentation from it.

# NOMENCLATURAL NOVELTIES
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